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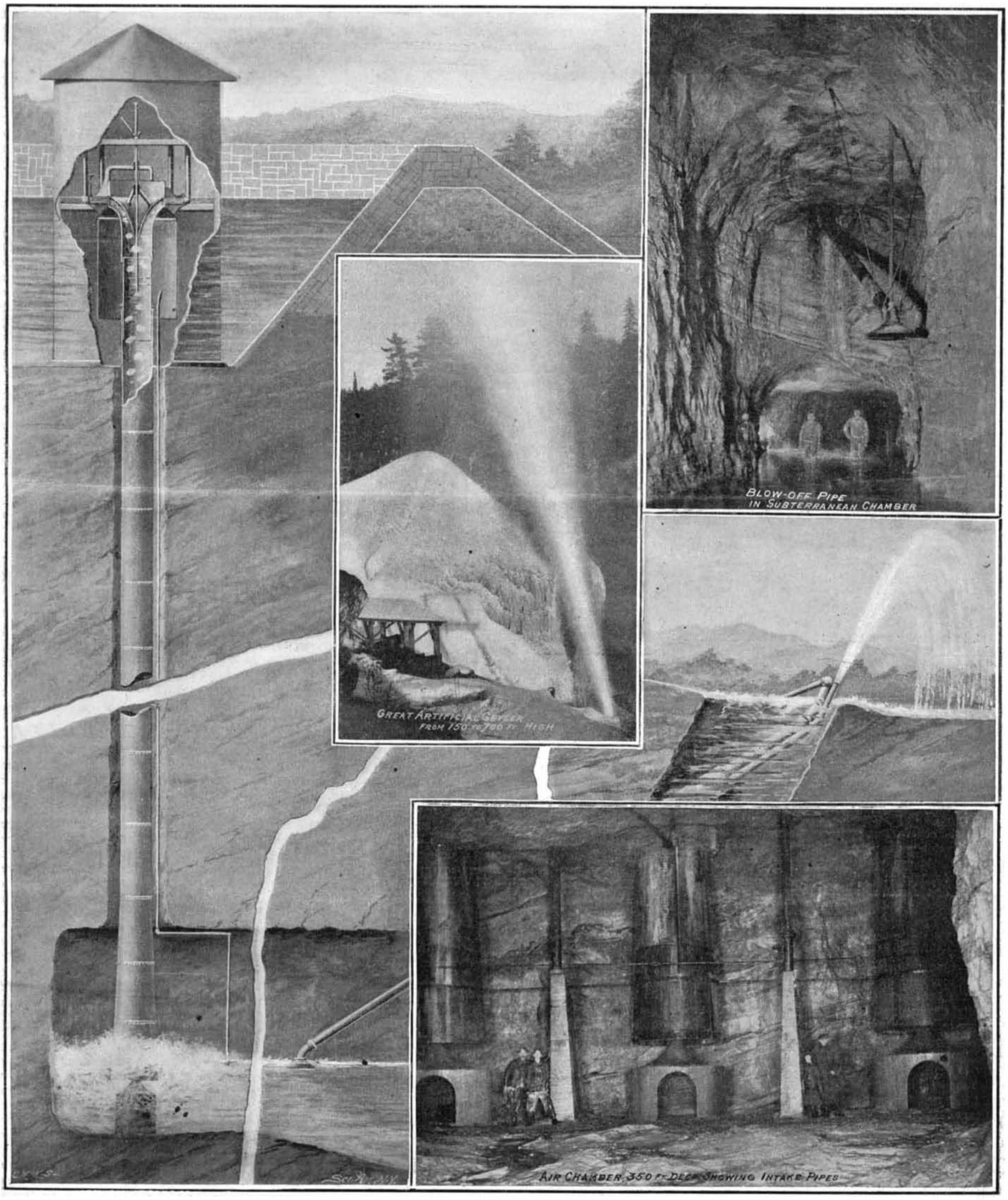
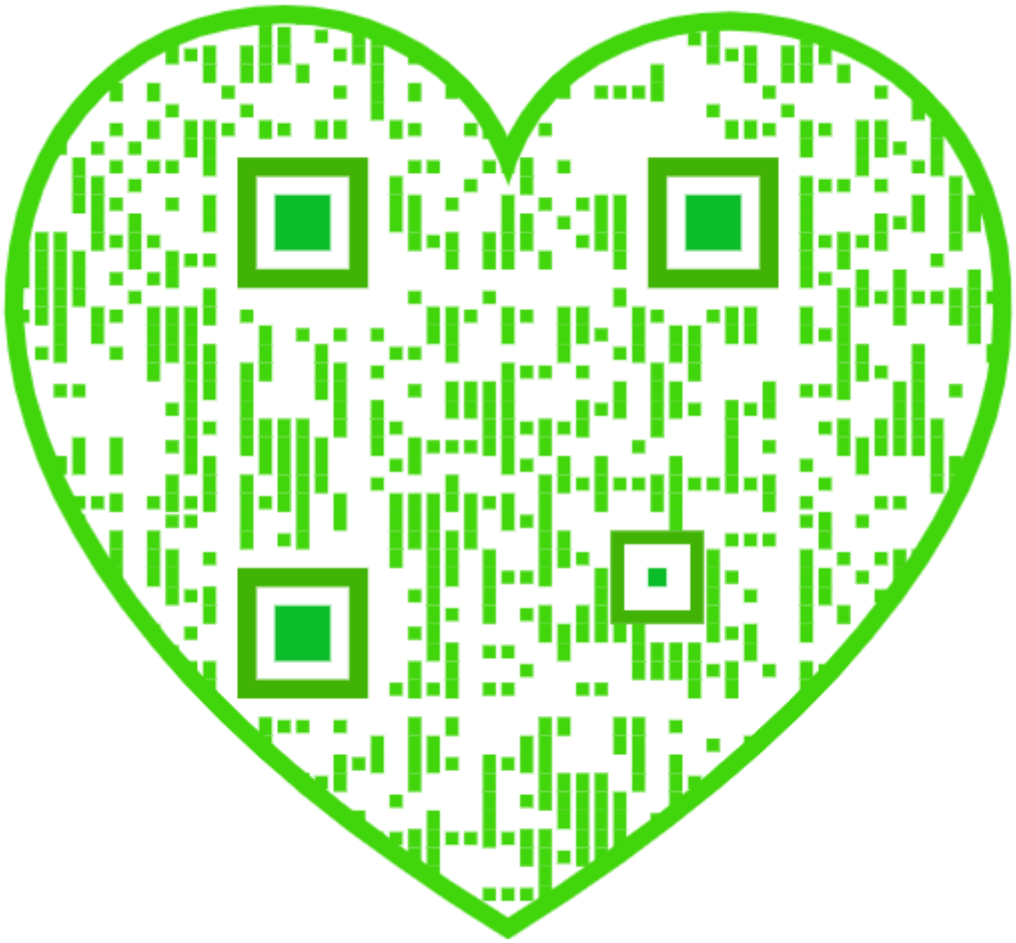

BLOW-OFF PIPE
IN SUBTERRANEAN CHAMBER
GREAT ARTIFICIAL GEYSER
FROM 150 TO 700 FT. HIGH
AIR CHAMBER 350 FT. DEEP SHOWING INTAKE PIPES

A HYDRAULIC AIR-COMPRESSING PLANT.

A Column of Falling Water Sucks Down Air Which is Trapped in a Chamber and Used for Driving Pneumatic Machinery. When the Air Pressure Becomes too Great It Blows Off in a Geyser of Spray.—[See page 231.]



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ESTABLISHED 1845

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NEW YORK, SATURDAY, MARCH 16, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

GOVERNMENT INVESTIGATION OF RAILROAD ACCIDENTS.

The increase in the number of railroad accidents during the past winter has been so alarming as to suggest the urgent need for some preventive measures, immediate and drastic. There is little hope of any movement looking to this end being made by the railroads themselves. They are too hopelessly hidebound in conservatism and self-sufficiency to admit that remedial measures can be taken that will have any material effect in decreasing, or rather in staying the increase in, the number of passengers and employees that are killed and wounded in the day-by-day operation of railroads.

The remedy must come from the outside, and it can be found in the introduction of that excellent system of government inspection of railroad accidents, which has been in vogue for many decades in some European countries, and notably in England, where government inspection has been the chief factor in the wonderful immunity from accident which the railroad system of that country has enjoyed. Although two or three serious accidents have caused the death rate to rise to an unusual figure during the past year, the average annual number killed is extraordinarily low, and recently in a single year over a billion passengers were carried without the loss of a single life. In the United States, where we have no adequate government inspection of accidents, our railroads, during a period of a little over six months of the present year, have killed, in generally avoidable accidents, well on to half a thousand passengers.

Under the British system of government inspection, if a railroad wreck involving loss of life occurs, the railroad officials are prohibited from clearing up the wreck, except so far as is necessary to rescue passengers, until it has been made the subject of a searching examination by the presiding engineer of a Board of Trade commission, appointed specially for railroad wreck investigations. Roadbed, ties, rails, wrecked engine and cars, are left *in statu quo*, in order that the government officials may have every possible scrap of evidence at hand that can in any way assist in determining the causes, immediate and remote, of the disaster. An elaborate report is then prepared and placed on record. It can readily be understood that these reports constitute an invaluable mass of data for the guidance of the railroads in the prevention of future accidents.

Compare that method with the system adopted in the United States, where, as soon as an accident occurs, and especially if it be one incurring heavy loss of life, the wrecking train is rushed down to the wreck, the wrecked cars dragged back onto the tracks and hauled away, the Lord knows where, and those cars that are so badly wrecked as to be incapable of replacement—the very cars, mark you, which could afford the strongest evidence as to the cause of the disaster—are burnt up at the side of the track, and the metal parts carted away to the junk pile. In a word, the evidence upon which an intelligent and impartial study of the wreck could be based, is swept out of existence by the wrecking crew. Frequently, the only fruits of investigation that remain are the individual impressions of this or that head of the department—superintendent, chief engineer, road master, or whoever may happen to be within reach of the wreck.

It is admitted that the leading railroads claim that careful investigations are made of every serious accident; but the results of these investigations are filed away in the secret archives of the company. Such lessons as may be learned from any particular disaster are confined to the officials of the road on which it takes place. There is no dissemination of information, not even among the railroads themselves; and as to the making public of such information, it is never contemplated for an instant. True it is, that the publicity bureau of a railroad is sometimes instructed to make a statement; but such investigations and statements are always *ex parte* in character; and we may be sure that, where an accident is directly due to poor equipment or faulty operation, the typewritten sheets of the publicity bureau will make no mention of the fact.

If the publication of the findings of the Board of Trade investigation of English railroad accidents ended the matter, these investigations would have merely an academic interest; but it is upon these findings that the government regulations affecting the construction, maintenance, and operation of railroads are based; and it is our belief that to this system of investigation, with its subsequent law-making, the English railroads owe their remarkable immunity from accidents.

The crying need of the hour is the institution of a government board for the investigation of accidents on United States railroads. This board should be composed of railroad engineers of ability and experience. They should be paid salaries commensurate with their reputation, and sufficient in amount to place them beyond any possibility of temptation. They, and their local representatives in the various parts of the country, should be invested with sufficient authority to enable them to make the most searching investigation and to enforce the attendance for examination of any official or employee from president to trainman. Upon this commission would devolve the duty of outlining such legislative measures as, in its opinion, were necessary to secure the safety of the traveling public. It is our firm belief that before such a commission had been in active existence five years, the number of railroad accidents in this country would have been cut down 50 per cent, and that before a decade had passed the number would have been reduced to the more humane figures which obtain on European railroads.

COMPARATIVE ECONOMY OF PRODUCER GAS AND STEAM.

It is known in a general way that a good producer-gas engine plant will yield a horse-power upon about one-half the amount of fuel that is necessary to generate one horse-power with a steam plant. The relative efficiency of gas and steam has recently been made the subject of analysis by a well-known pioneer in the field of producer gas, J. M. Emerson Dowson, who bases his comparison upon a steam and gas power plant, each of a capacity of 250 horse-power. In the case of the steam plant, he finds that of 1,120 heat units contained in the fuel, 224 units are lost in radiation, flue gases, ashes, etc., and that 896 units appear in the steam that is generated. Of this amount, 112 units are lost by condensation in the pipes, etc., leaving 784 units that are supplied to the engine. Of these, 667 units are lost in the exhaust, leaving only 117 units to be converted into work in the engine. Of these, 17 units must be deducted for engine friction, leaving only 100 units, out of 1,120 originally in the fuel, available for useful work on the engine shaft. In other words, in order to obtain 100 heat units in useful work on the shaft of a steam engine, there must be 1,120 heat units in the fuel burnt up in the boiler. A similar investigation of the producer-gas plant shows that there need be only 525 heat units in the fuel consumed in the producer to give 100 heat units of useful work on the engine shaft. In the producer-gas engine 105 units will be lost in radiation, etc., from the gas plant; 126 units will be lost in cooling the engine; 177 will be lost in the exhaust, and there will remain only 117 units to be converted into work in the cylinder, of which 17 will be lost in engine friction, finally leaving 100 units to perform useful work. This comparison shows a saving in fuel of 53 per cent in favor of the producer-gas plant. A comparison by the same authority of two 40-horse-power plants, gas and steam, shows a saving of 70 per cent in favor of the gas plant. Excellent as is the economy of the gas plant as shown by these figures, it must be noted that the heat losses are still very large, and future improvement in economy must be looked for mainly in this direction, both in the gas plant and in the engine.

PROGRESS ON THE ERIE CANAL.

As in the case of the Panama Canal, the work hitherto accomplished on the Erie Canal has included a large amount of preliminary operations which do not figure in the statistics of total excavation done in the prism of the canal. At the present writing, over $35,000,000 worth of contracts are either ready to be let or have just been let, and these, when completed, will cover 209 out of the total 440 miles of canal to be excavated. Some conception of the magnitude of the preliminary work which has already been done may be gathered from the fact that the corps of engineers engaged on the surveys have run levels over nearly 1,500 miles, have done the transit work over more than 1,000 miles, and have completed the topographical maps of 130 square miles of territory. The investigation of the sub-surface along the route of the canal by drilling in earth, sand, and stone, has been carried out on a vast scale, the total amount of drilling that has been done amounting to over 40 miles of vertical depth. At the time of the last report of Col. Thomas W. Simons, consulting engineer in the construction of the work, which was made in January of the present year, the work under contract covered a distance of 70 miles and represented a prospective outlay of $20,000,000. A fact, most encouraging and very unusual in work of this character is that every item of expenditure thus far placed on record is below the estimated cost. On that portion of the work then under contract, there had been a saving of nearly $3,000,000 over the preliminary estimates. We have often had occasion to speak in these columns of the far-reaching effect in economy of time and expense which will be produced in engineering works by the extended use of concrete in place of stone masonry. In the present report, the extent of this economy in works of magnitude is forcibly illustrated, for Col. Simons states that when the Board of Engineers decided to use concrete instead of stone for the masonry of the canal, a saving of $16,000,000 was effected on this item alone. The report closes with the welcome statement that the last vestige of organized opposition to the canal work has disappeared. Although this opposition was at one time very active, the interests that were opposed to the improvement of the canal have abandoned their attitude, and no effort is being made in any quarter to hinder the prosecution of the work.

COMPLETION OF THE SECOND TUBE TO BROOKLYN.

With the completion, a few days ago, of the second of the twin tubes by which the Rapid Transit system of this city is being carried beneath the East River, the linking up of Brooklyn and Manhattan by an unbroken stretch of Subway tracks is brought one step nearer realization. Compared with the work of driving the longer tunnels beneath the Hudson River, the construction of the tubes beneath the East River has been a far more formidable task. If we except the difficulties encountered by the English company which attempted to drive the first tube beneath the Hudson River, the work of connecting Manhattan and New Jersey has not been attended with very serious trouble; at any rate, if there have been difficulties, they have been overcome so quietly that the public has heard very little about them. The East River, however, has proved a very difficult proposition, largely because of the varying character and consistency of the material through which the tubes had to be driven, sand, rock, and mud being successively encountered. It is to this variation of the material of the river bottom, coupled with what we have always considered to be the over-light construction of the tubes, that the trouble in the way of faulty alinement and elevation and the distortion of the tubes themselves, is largely due. The bending stresses at the point where the tubes pass rather suddenly from solid rock into soft mud have been so great as to crack some of the plates, and most of the delay on these tunnels has been due to the necessity of repairing these broken plates, and restoring the grade of the tunnel at points where it had fallen below the proper elevation.

PRESERVATION OF STEEL WORK IN TALL BUILDINGS.

The question of the probable condition of the steel work of the modern office building, shut in, as it is, beyond the possibility of inspection, is one which has often been asked and very seldom definitely answered. During the past two years there have been a few opportunities presented by the demolition of skeleton steel buildings, to determine the amount of deterioration of steel when it is inclosed in masonry. But in each case the period of time which had elapsed since the erection of the building was too short to afford any adequate test; that is, a test from which definite conclusions could be drawn. A few months ago, however, during the reconstruction of San Francisco, it was found necessary to remove the six upper stories of the Mutual Life Insurance Company's building in that city; and as the building, which is a steel frame structure, was erected in 1893, the intervening thirteen years may be considered to have afforded an excellent test of the tendency to rusting, in a building of this character. The condition of the building, as described by Mr. F. B. Gilbreth, who had the contract for removing the top six stories, shows that it was of the best construction of those days, and that the laying up, and filling of joints in the brick, stone, and terra cotta was as nearly perfect as possible. The exterior walls completely inclosed the steel frame, which was put together with bolted connections. The floors were of hollow terra cotta arches and the partitions were hollow terra cotta blocks. According to the testimony of several occupants, the earthquake did practically no damage to any part of the structure, and in taking down the building there was no evidence that it was in the least injured by the heavy earthquake shocks.

The damage from fire was similar to that observed in the Baltimore and other big conflagrations. Com-

mon red-clay bricks stood the heat better than any other material; but according to Mr. Gilbreth the floor blocks and partition blocks showed that terra cotta, in spite of the fact that it is incombustible, is a very unsatisfactory material to use in connection with steel. It expands so much more quickly than steel that it breaks up and falls apart by buckling long before it is ruined by fire or water.

The condition of the steel work of a steel frame building thirteen years old is, of course, the most interesting feature of this reconstruction. The structural steel had originally been covered with red metallic paint, and where this paint was in contact with lime mortar, the steel was found to be in very good condition and showed little indication of rust. This excellent preservation was due to the fact that the joints in the brickwork were exceptionally well filled, and the mortar well rammed in around the columns. There were some instances where the mason had been unable to slush in the mortar as well as might have been wished around the columns, and in one of these instances there was found a piece of rust scale larger than a man's hand; but this was the very rare exception. Indeed, the beams from which this particular piece of rust was taken would stand comparison with the average steel beam that had been in stock in a steel yard for several months. Where the steel had not been thoroughly cleaned before painting, there were occasional instances of some rust under the paint. Such cases were comparatively rare; and Mr. Gilbreth sums up with the statement that with these exceptions, the rust had not developed in thirteen years beyond a negligible amount, the straight columns, beams, tie-rods, and bolts being subsequently sold for use in new buildings now in progress of erection.

GLASGOW AND MUNICIPAL OWNERSHIP.

BY DAY ALLEN WILLEY.

The city of Glasgow is the most notable community in the world from the standpoint of municipal ownership, owing to the various enterprises in which it engages, from housing its people to providing them with transportation. The operation of its street railway system through municipal control was one of the first ventures of this kind, being inaugurated in 1889, when animal power was utilized entirely for hauling the street cars. At that time but three communities in Great Britain operated their street car systems. In 1904, however, no less than fifty communities controlled these utilities, the majority of them adopting the municipal ownership idea on account of the success which attended the experiment in Glasgow. The street railway system in this city serves a population of about 1,000,000 in Glasgow and its suburbs. At the present time it comprises 169 miles of surface track and a double-track subway, which is about 6½ miles in length. All of the surface lines are operated by electric motors, the cars being propelled by the overhead trolley system so familiar in the United States. The cars, which are also constructed and equipped at plants owned and operated by the municipality, are of two kinds, one having seats on the top to accommodate passengers who may desire to ride outside. These are known as "double-deckers," and will seat about forty people, the cars provided with seating capacity inside only accommodating but twenty-five. As in other cities in Great Britain and on the Continent, a car is considered full when all of the seats are occupied, and no more passengers are permitted to enter, in contrast to the American system of crowding people into the cars until all of the available standing room is occupied.

To furnish adequate service in the city and suburbs about 800 cars are provided, each equipped with a series of motors developing about 50 horse-power on the average. Although the number of cars is small considering the extent of the traffic, the service is such that there is little cause for complaint as to the frequency of the trips or the speed maintained. Yet during the year ending June 1, over 208,000,000 passengers were carried, an increase of nearly 100,000,000 since 1899—illustrating how the traffic has expanded in less than ten years on account of the facilities afforded for cheap trips. This is indicated by the number of persons who have been carried during the year at the different rates of fare charged. No less than 29½ per cent paid an average of but one cent in American money, while 60 per cent paid an average of two cents a ride, and only 7 per cent three cents a ride. Actually less than one per cent of the total number of fares collected averaged five cents, the usual rate on street railways in American cities.

The Glasgow street-car system has not only been noted for the low rates of fare charged, but for the remarkable success it has attained from a financial point of view. To show how the venture pays the city, a few statistics of the receipts and expenses may be given. During the year ending June 1—the last complete year reported—the total income amounted to $4,100,000 in American money. After deducting the operating expenses amounting to $2,280,000, a balance was left of $1,820,000. Out of this, $300,000 was appropriated for taxes and interest, and $850,000 for estimated depreciation of property and maintenance of way and rolling stock. From the balance, $175,000 went to what is known as the "fund of common good." After deducting all of these payments there was placed to the credit of the general reserve fund about $200,000. Contrasting these items with the amounts allowed for depreciation and other expenses in connection with the operation of American street railways, it is apparent that the Glasgow corporation pursues a very generous policy as to renewals and betterment, but the fund of common good is being accumulated in connection with the sinking fund, and this now amounts to such a sum that the entire indebtedness incurred in purchasing, rebuilding, and equipping the railway system has been reduced to $8,500,000. As there are no dividends to be paid, the portion of the surplus available for such payment is practically included in the sinking fund provided for the liquidation of all indebtedness. It may be added that the sums appropriated for maintenance and depreciation represent no less than 6 per cent of the total capital invested.

Not only the city itself, but the principal highways leading into it are served by the electric railway system, the corporation securing permission to lay its tracks on the suburban roads from the local authorities. In return for this privilege it guarantees to keep a certain portion of the highway properly paved and in good condition. While the overhead trolley system, as already stated, is used entirely on the surface, the poles are of an ornamental pattern and the overhead construction is very different from the unsightly work so often seen in American cities. Soon after the municipal authorities took control of the street railway system, it was decided to discontinue the use of any of the cars for advertising purposes. This meant an annual loss of about $50,000, but the improvement in the appearance of the cars has compensated for it at least in part. The total number of employees is about 3,200. It is an interesting fact that since the city assumed control of the service it has reduced the time of working hours from twelve hours out of twenty-four to an average of nine hours per day, the average wages of motormen and conductors being $1.16 in American money.

From the main power station during the last year a total of 26,340,000 kilowatt-hours were generated, of which about 1,000,000 were utilized at the station itself. The percentage of current lost in transmission and conversion was about 11 per cent, the current supplied for operating street railway motors aggregating about 20,000,000 kilowatt-hours, the average cost per hour for electricity after allowing for loss, taxes, insurance, and depreciation of the equipment was about 2.1 cents per kilowatt-hour. This estimate is based on a charge of one-fifth of a cent per hour for fuel, the coal averaging about $1.75 per ton in American money. In addition to supplying the street railway service the corporation sold electricity for industrial and other purposes at a price averaging three cents per kilowatt-hour, indicating the profit which it obtained from the disposal of the current in this way.

The success attending the operation of the system has caused the Glasgow corporation to plan several extensions to the present system. It has obtained authority to construct lines within the city and suburbs which will aggregate 27 miles and will be completed in the near future. These extensions have necessitated the enlargement of its plant for manufacturing cars which is even now very extensive. An addition is now under way which will be completed during the present year. It may be added that the municipal car factory is provided with a full equipment of modern power tools both for wood and metal working, and that nearly all parts of the cars are manufactured here as well as assembled and finished. A considerable portion of the power is electric current supplied from the station, many of the tools being driven by individual motors instead of steam power.

THE CURRENT SUPPLEMENT.

The electrification of the Simplon Tunnel railroad is the subject of the opening article of the current SUPPLEMENT, No. 1628. The article is exhaustive, and is accompanied by many clear photographic illustrations. Mr. A. Frederick Collins contributes the last of his series on a 100-mile wireless telegraph outfit. In this installment he writes on the management and operation of ship and shore stations, giving alphabets which are employed in this country and abroad, as well as call letters of the United States naval stations, weather symbols, wind symbols, telegraphic abbreviations in common use, and a communication chart for steamships. Mr. F. Z. Schellenberg contributes an article on "Our Coal," in which he tells not only how coal is mined, but also something of the conditions which affect the miners. Mr. C. J. C. Zintheo's elaborate paper on Corn-Harvesting Machinery is concluded. Mr. C. W. Parmelee likewise concludes his discussion of the technology and uses of peat. Of technological value is the article on gold and aluminium solders. Excellent formulas are given. The second installment of the article on the manufacture of water-gas is published. The article on the distillation and rectification of alcohol is concluded.

SCIENCE NOTES.

Rich deposits of phosphate are reported to have been discovered recently in Riverside County, California, 1,500 feet above sea level, four miles from Whitewater, on the Southern Pacific. The deposits lie in a cup-shaped valley overlooking the desert and within thirty-five miles of the Salton Sea. The discoverers were prospecting when the find was made. It was before the recent storms. They were suddenly stifled by the stench, and realizing its cause followed against the wind until they stumbled upon their find in the valley. With the first rain the stench disappeared. The deposits are said to extend to a considerable depth and to cover hundreds of acres.

A little-known phase of entomology is discussed by Leinemann in his article on the number of facets in the eyes of insects, published under the title "Uber die Zahl der Facetten in den zusammengesetzten Augen der Coleopteren." He has had the patience to count the facets in the eyes of 150 species of beetles. He finds that the larger the specimen, the more numerous are the facets, and that usually there is not much difference in the sexes. The male in many cases, however, has more facets than the female. In *Lampyris splendidula* the male has 2,500 facets, while the female has but 300. *Melolontha vulgaris* has, male, 5,300, female, 4,850; and *Saperda carcharias*, male, 2,200, female, 1,800. There is no general reduction in nocturnal species.

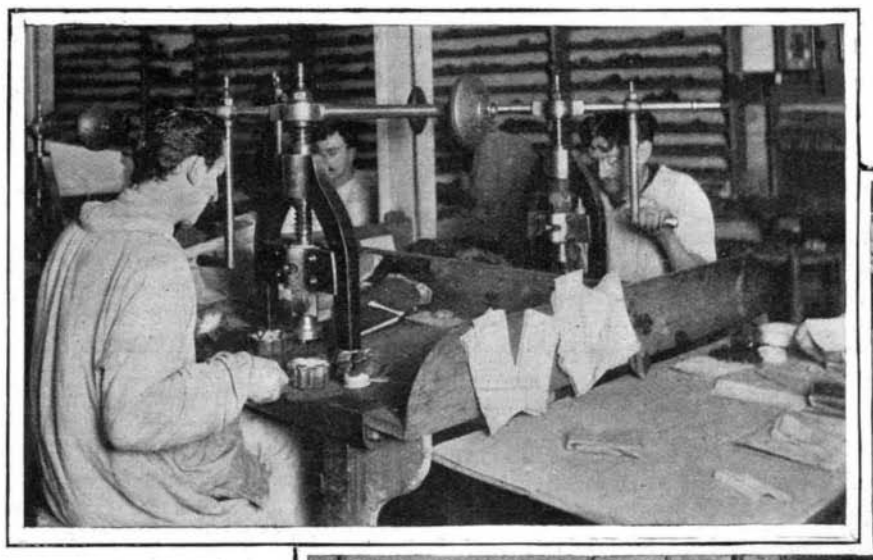
A public museum combined with a laboratory has recently been inaugurated at Brussels. This establishment was founded for encouraging the development and expansion of electrical work in the country as a result of experimental teaching, and to this end the museum has been equipped with all kinds of models and apparatus which the visitor can observe and try upon the spot. The museum contains four main halls, where all the apparatus is installed. One of the halls is devoted to the demonstration of the laws of the electric current, while in a second hall is found a collection of all the machines which give rise to electric or magnetic phenomena, as well as electro-chemical apparatus of various kinds. A gallery which forms part of the second hall contains an exposition of apparatus such as lamps, agricultural machines, etc., and the latter are driven by motors. The sections of telegraphy, radiotelegraphy, and telephony are well equipped with modern apparatus. In the third hall is installed the reading room, which is large in size. Many scientific publications are received here. The fourth hall contains the heavy electric machines, such as dynamos and motors. A number of professors is attached to the establishment, both for lecture and laboratory work.

The Austrian explorer Dr. Erich Zugmayer, who for some time past has been engaged upon important explorations in the unknown parts of Thibet, and who was compelled at last to abandon his journey only because of pronounced hostility on the part of the natives acting upon instructions from the Grand Llama at Lhassa, and intense privations due to climatic influences, achieved success from geographical, zoological, and botanical points of view. The hardships encountered on the journey were of an exceptional character, due chiefly to the climatic conditions prevailing and the rough character of the country traversed. His route extended toward the south and southeast and led through an entirely unknown part of the country. For two months the party continued its way with extreme difficulty at an altitude of 16,000 feet. Great suffering was entailed by the transport animals because of the hardships and abnormally severe weather encountered at those altitudes. When the party had reached a point at an elevation of 20,000 feet above sea level, Dr. Zugmayer, owing to the mortality among his animals, was compelled to abandon his projected route, and struck off in a westward direction to Kashmir, which had been his original objective by the more circuitous route. Despite the difficulties encountered and the enormous losses among the transport animals, the explorer was enabled to preserve the many valuable specimens he had collected. The return journey was made past the Rudok and the Panggong lakes. Upon arrival at Kashmir the explorer had only twelve emaciated yaks left, testifying to the arduous nature of his journey. In addition to mapping out a considerable portion of Thibet, hitherto unknown, Dr. Zugmayer has collected considerable data which will enable revisions of the existing maps of the country to be carried out, since he states that the latter are very erroneous. One fact he has conclusively established, and that is the recent volcanic conformations that have taken place in Thibet, a point which has been the subject of great discussion recently. At altitudes ranging between 16,000 and 20,000 feet he secured numerous botanical specimens which are of great value, while he also discovered twenty new species of animals and fifty new groups of smaller animals.

MAKING ARTIFICIAL FLOWERS.

BY JACQUES BOYER.

Artificial flowers and leaves are made of silk and cotton fabrics stiffened with starch paste which is prepared in the apparatus shown in one of the illustrations. From the upper tank, heated by gas, where the starch and water are mixed together the paste passes through a sieve to the lower tank where it is kept in continual agitation by a rotary stirrer and cooled by cold water circulating through pipes. From this tank the paste is dipped and poured through a second sieve into a cask. The fabric is plunged into the paste, wrung out, and stretched on wooden frames, the bars of which can be moved by screws to regulate the tension of the fabric, and the layer of paste is made uniform by parallel strokes in one direction with a broad, fan shaped brush. Here the fabric is allowed to dry and if it is to be used in making leaves or petals of uniform color, the proper pigment is applied with a brush. It then goes to the cutting room. The cutting is done, by hand or machine, with punches of a variety of forms, shown, arranged on trays, in one of the illustrations. The cutter sits on a stool before a great wooden cutting block covered by a cushion supporting a thick sheet of lead, on which from two to four thicknesses of the prepared fabric are laid. The punch is guided with the left hand and struck with a heavy mallet held in the right. The operation of cutting by machine is similar, except that the mallet is replaced by a vertical steel beam moved up and down by an eccentric. Girls then fasten to the cut-out leaves pieces of fine cotton-covered brass wire which give them stiffness and represent the leaf stalks. The veins and folds of the leaves are imitated by pressing the pieces forcibly, in a hand press worked by a vertical screw, between a copper plate engraved with a design in intaglio and an iron plate which bears the same design in relief, the two plates being hinged together to insure exact correspondence of the designs.



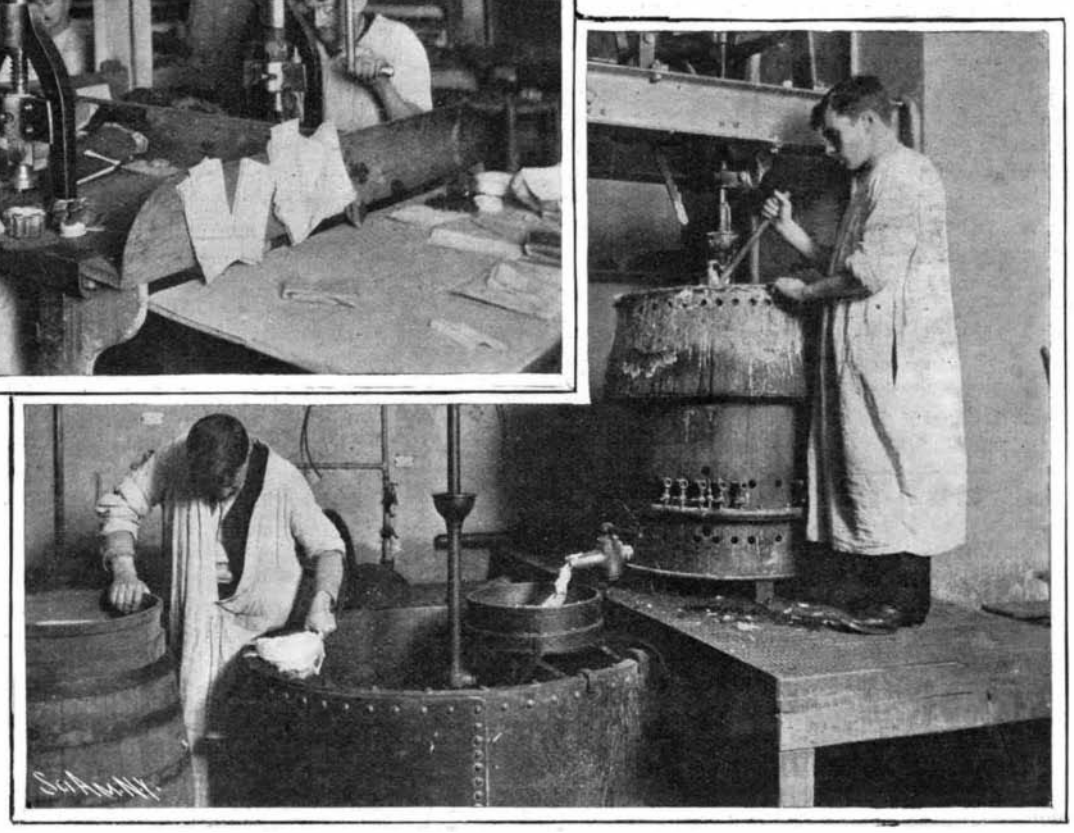
Stamping and Veining Machine.

On leaving this apparatus the artificial leaf is a pretty good imitation of its natural model but, like an oil painting, it needs a final operation—varnishing.

For this purpose the leaves are immersed in melted wax in basins heated by gas. A mere dip suffices for a small leaf, but a large one is rotated by rolling the stalk between the hands to assure contact of the wax with every part. The soft, velvety appearance which is characteristic of the leaves of some plants is obtained by dusting the waxed and re-heated leaf with fine starch, equalizing the coating with a soft brush and removing the excess of starch with a coarser brush.

Striped leaves are imitated by means of stencils, the colors being applied with a brush. Irregular markings are imitated by free-hand painting. The large leaves of *Sedum* and other *Crassulaceæ* receive one or more coats of colored starch paste before being varnished. The edges of the leaves of rosemary, etc., are curled with hot pincers. Finally, the leaf stalk is usually covered with silk paper.

Stems composed of fabric are made by a machine in which three ribbons cut bias are unrolled from bobbins and pass through spiral metal tubes heated by gas which cause them to curl like shavings, and form little tubes which preserve their shape even when reeled. Stems are also made of India-rubber tubes. These are painted green and after drying are tinted brown on one side by a spray of color from a vaporizer, which gives them a very lifelike appearance. Even the thorns of roses, and acacias are sometimes imitated in sheet rubber cut out with a punch. In copying an entire shrub, such as the lilac herewith illustrated, the skeleton of the trunk and branches is wrapped with strips of suitable fabric which are then colored by hand before the leaves and flowers are attached. For the imitation of heather a machine has been invented which cuts a ribbon into very narrow strips which remain attached to each other at their bases. When these ribbons are wrapped around brass wires the irregular fringe thus formed imitates natural heather to perfection.



Making Starch Paste.

The manufacture of petals differs from that of leaves. Petals are colored by hand and are shaped, curled, and fluted by means of pincers and little balls of metal manipulated by skillful workwomen, who quickly impress the variety of nature on a mass of previously identical petals. Other women, equally adroit, sit at tables strewn with petals, calyxes, pistils, and stamens, which they rapidly assemble in accordance with the laws of botany. The parts of the flower are fastened together by wrapping them with fine brass wire. The flowers then go to women who arrange them in bouquets, baskets, wreaths, and more elaborate pieces. The artificial flowers made in Paris are celebrated throughout the world despite the competition of the flower makers of England, Germany, Belgium, Italy, the United States, and Brazil.

Drainage of the Florida Everglades.

The land known as the Florida Everglades has been of historical interest since the seven year Seminole Indian war, which ended in 1842, during which time a meager knowledge of that peculiar area was obtained and later published in various brief reports. Its reclamation for farming purposes has generally been regarded as impossible, or at least so visionary as to merit no attention until recently. The preliminary work for its drainage, inaugurated by the State in 1906, is sharply criticised in many quarters and bitterly opposed in others. There is no question but that this area occupies a most unique position among the various drainage projects now receiving attention in various parts of the country. It is a swamp plain extending from the south shore of Lake Okeechobee to the south boundary of the State, 5,000 square miles in extent and covered with saw grass of extraordinary height, relieved by scattered hillocks which are covered with pine, palmetto, and various subtropical bushes. This plain is covered with water to various depths during the entire year.

Whenever the question of the agricultural possibilities of the Everglades is raised, several problems present themselves for solution. One is the removal of the excess of water, which makes this the largest swamp area of the country. Not only is there an annual rainfall of 60 inches to be considered, but water is also contributed by the overflow of Lake Okeechobee, which receives the drainage of not less than 5,000 square miles from the northern portion of the State, and has only one small relief channel, the Caloosahatchee River, which discharges westerly into the Gulf. This being inadequate, the lake spills over on the glade lands lying at the south.

The depth and structural character of the soil has not been determined nor studied closely. The Disston sugar plantation, established several years ago north of Lake Okeechobee but now abandoned, demonstrated that the muck soil in that locality when drained produced sugar cane of superior quality and quantity. The stability of artificial drainage channels in this territory, the control of the water level in soils of a muck or peat character, and the amount of shrinkage likely to take place where drainage is accomplished, are yet subjects of speculation. Those glade lands whose producing properties have been tested are confined to the little glade openings at the border of the great swamp, which are not muck lands, and in this

Making Wreaths and Crosses of Artificial Flowers.

Varnishing Leaves.

MAKING ARTIFICIAL FLOWERS.

respect are wholly dissimilar to those in the interior, as far as examinations have disclosed their character.

While the State Drainage Board of Florida has begun to dredge the channel from the head of New River at Fort Lauderdale, on the east coast, northeasterly to the southern border of Lake Okeechobee—the first move made toward the drainage of any considerable portion of the Everglades—these and other undetermined matters essential to the ultimate success of this vast reclamation project still confront the State and other owners of land to be affected. The State Board, appreciating this state of affairs, has through the governor asked that the U. S. Department of Agriculture, through irrigation and drainage investigations of the Office of Experiment Stations, make the matter a subject of special investigation and report.

A preliminary examination of the Everglades was made by Mr. J. O. Wright, drainage engineer of the Office of Experiment Stations, followed by a conference with the governor and a number of members of Congress of Florida, which resulted in the Office of Experiment Stations undertaking an investigation, which includes the running of a line of levels from the west to the east side of the Glades, something never heretofore attempted. This survey was begun at Fort Myers in January last. It is in charge of Mr. John T. Stewart, assisted by Lawrence Brett, drainage engineers of the Office of Experiment Stations. These engineers have a corps of assistants equipped for making all the necessary engineering and physical examinations. The line of levels, which starts at tide water at Fort Myers, will be carried across the State, connecting the surface of Lake Okeechobee and the upper part of the Everglades with tide water at the east coast. Examinations will be made of the physical structure and depths of muck or other material overlying the rocks which is said to constitute the substrata of the entire area.

This preliminary examination relating to the agricultural possibilities of the historical Everglades includes not only instrumental engineering, but problems in drainage construction and consideration of the subsequent behavior and value of the soil for productive uses. The examinations will be made with a view to determining the most feasible and practicable plan for draining the whole or a part of the Everglades, in which will also be taken into account their probable agricultural value when drained. If the land can be successfully reclaimed, its value will be measured largely by the staple subtropical crops that may be produced and exported. It is expected that the investigations already begun will be continued until some definite conclusions have been reached upon all of the doubtful and undetermined factors pertaining to the drainage of the Florida Everglades.

Building a Tree.

Cutting Out Leaves and Petals with Hand Punches.

Preparation of a Moth-Exterminating Powder.

The following recipe for preparing a moth-exterminating powder called "Antimothine" is given by the Pharmazeutische Zeitung of Berlin: 500 parts by weight of finely-sifted sawdust are thoroughly mixed with 5 parts of powdered ammonium carbonate, prepared with oil of lavender. To this 10 parts of glacial acetic acid, mixed with 10 parts of water, are added and mixed until the effervescence, caused by the acetic acid, has ceased. By this treatment, the sawdust is made ready for the admixture of further ingredients. A second mixture is then prepared as follows: 500 parts by weight of finely-sifted sawdust are mixed with 20 parts of glacial acetic acid, diluted with 20 parts of water, 15 parts of spirits of wine, in which 5 parts of camphor have been dissolved, and 10 parts of American turpentine oil. This second mixture is then added to the first, and 40 parts by weight of ammonium carbonate prepared with oil of lavender added to the whole. The mass is left to dry in a well-closed receiver.

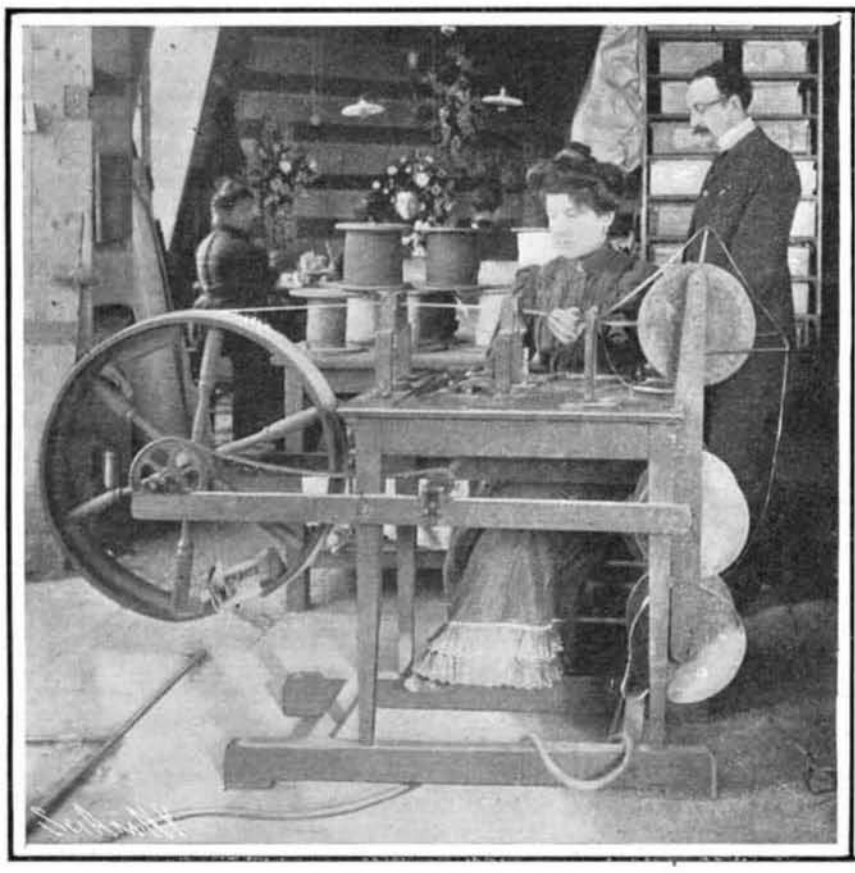
When required for use, the powder is scattered in rooms or receptacles containing the articles which are to be protected from moths, the articles being either suspended over it or laid in it. The powder may, however, be strewn over the objects in the usual manner, without the latter suffering any injury. Owing to the fact that the active constituents are contained in the vehicle (cellulose) in a finely-divided state, their action is certain and lasting; moreover, an agreeable smell, injurious to moths, is developed by the ammonium carbonate prepared with the oil of lavender.

Other suitable substances capable of absorbing the active constituents, such as infusorial earth, sponge, etc., may be used instead of sawdust, as they are more or less substitutes for cellulose.—Neueste Erfindungen und Erfahrungen.

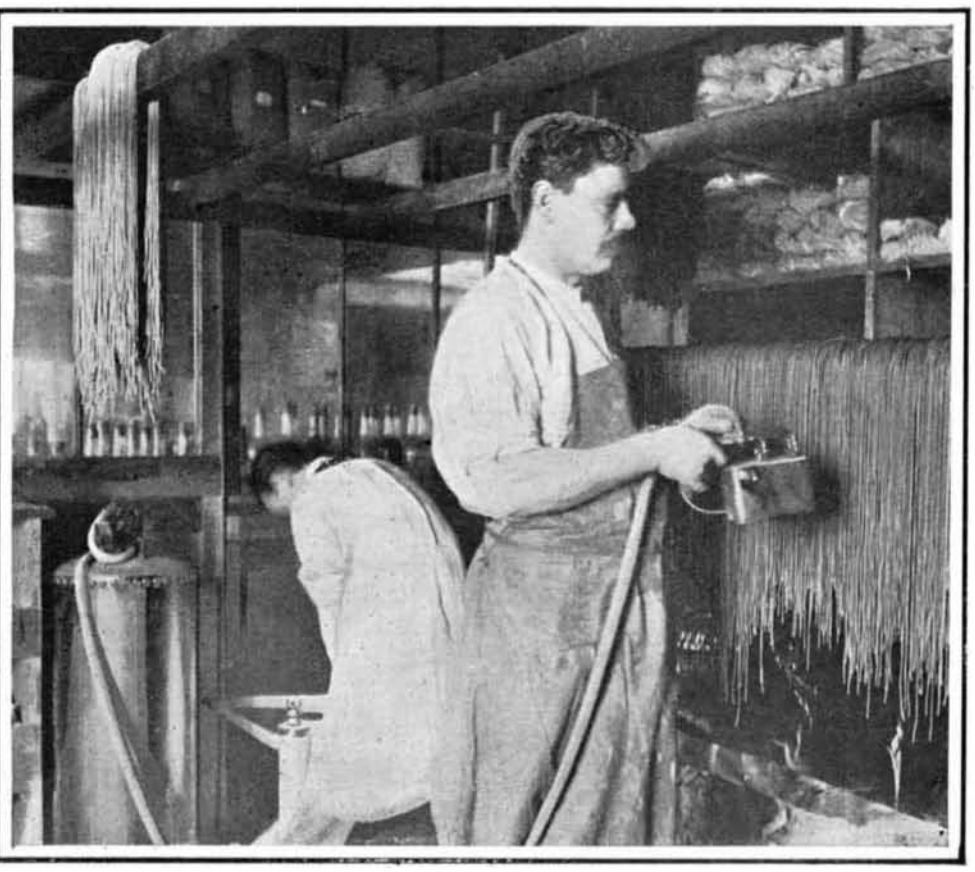
The Size of the Atom.

John A. Brashear, in an address delivered at Lehigh University a short while ago, gave what seems to be a new illustration of the minuteness of the atom. Quoting Lord Kelvin's saying that: "If we raise a drop of water to the size of the earth and raise the atom in the same proportion, then it will be some place between the size of a marble and a cricket ball," Mr. Brashear then said:

If you fill a tiny vessel one centimeter cube with hydrogen corpuscles, you can place therein, in round numbers, five hundred and twenty-five octillions (525,000,000,000,000,000,000,000,000) of them. If these corpuscles are allowed to run out of the vessel at the



Making Stems of Cloth.



Spraying India Rubber Stems with Brown Pigment.

MAKING ARTIFICIAL FLOWERS.

rate of one thousand per second it will require seventeen quintillions (17,000,000,000,000,000,000) of years to empty it. Such a computation seems almost like trifling with science, indeed apparently trifling with the human intellect; but it is with these subtle theories that our physicists are wrestling, delving into the innermost chamber of the infinitely minute, to build for us, upon the most stable foundation, the macrocosm of a universe.

Immigration Increasing.

During the fiscal year ended June 30, 1906, a record was established in the matter of immigrants who entered the ports, eclipsing all former years. During that period no less than 1,166,353 aliens were admitted, of whom 1,100,735 were immigrants. The increase over 1905 was 106,598. During the year 1905 11,480 aliens were rejected, and in 1906, 12,432. Of the immigrants, 764,463 were males and 336,272 females.

Most noticeable is the increase in the percentage of immigrants from the countries of southern Europe, and the decrease from those countries from which the United States in former years received most of her future citizens. During 1906 those countries of northern Europe whose people and ideas are very similar to our own furnished but few immigrants. Of these, there were from Ireland, 17,950; England, 15,218; Sweden, 3,281; Germany, 3,010; Denmark, 1,229, and Scotland 1,111 less than in 1905. On the other hand, from Italy came 5,165; Russia, 30,768; Greece, 8,974, and Turkey 5,165 more than in the previous year.

The immigration from Austria-Hungary amounted to 265,138; Italy, including Sicily and Sardinia, 273,-120; Russia and Finland, 215,665; China, 1,544; Japan, 13,835; the West Indies, 13,656.

The large amount of emigration from southern Europe is due to the very general unrest existing among the laboring classes of those countries, and a very reprehensible activity on the part of agents of transportation companies, who, in order to secure passengers for their respective lines, are often guilty of gross misrepresentations of conditions and advantages in the United States, represented as a land of boundless plenty for all. The mental and physical grade of the immigrants now entering the United States is said by the Commissioner-General of Immigration to be much lower than in former years.

Of the immigration of 1906, the North Atlantic and North Central States received 90 per cent of the total, and the South 4 per cent. The bulk of the immigrants avowed their intention of locating permanently in the larger centers of population, 374,-708 declaring New York State to be their destination, 198,681 asserting that they were going to Pennsylvania, 86,539 to Illinois, and 73,863 to Massachusetts.

Number of Motor Cars in France.

The number of motor cars in France which paid the tax in 1905 was 21,523, with an aggregate of 179,361 horse-power. Of the total, 45,346 horse-power belonged to the Department of the Seine, the number of cars being 4,627, or an average of nearly 10 horse-power per vehicle. In the remaining departments the number of motor cars was 16,896, with a total of 134,015 horse-power, or an average of about 8 horse-power.

The Porquerolles wireless telegraph station regularly receives messages sent from Land's End; and now space telegraphy has been accomplished over a far greater distance. Quite lately a communication transmitted from the Eiffel Tower was recorded at the Biserte station, which is not laid out for long distances; and the circumstance was considered sufficiently interesting to be telegraphed to the ministers.

HOW TO STUDY A STAR MAP.

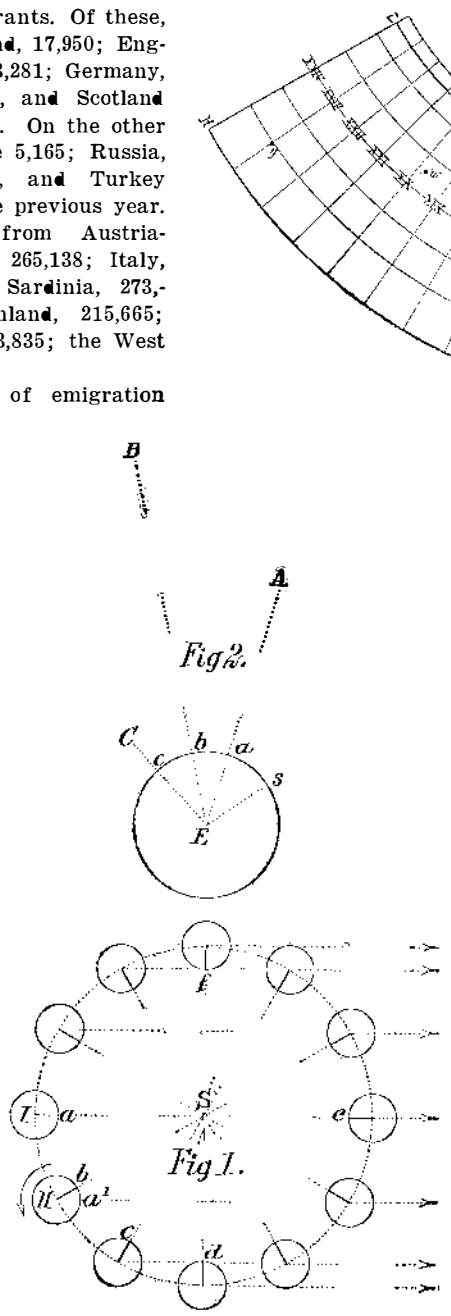
BY FREDERIC R. HONEY, TRINITY COLLEGE, HARTFORD.

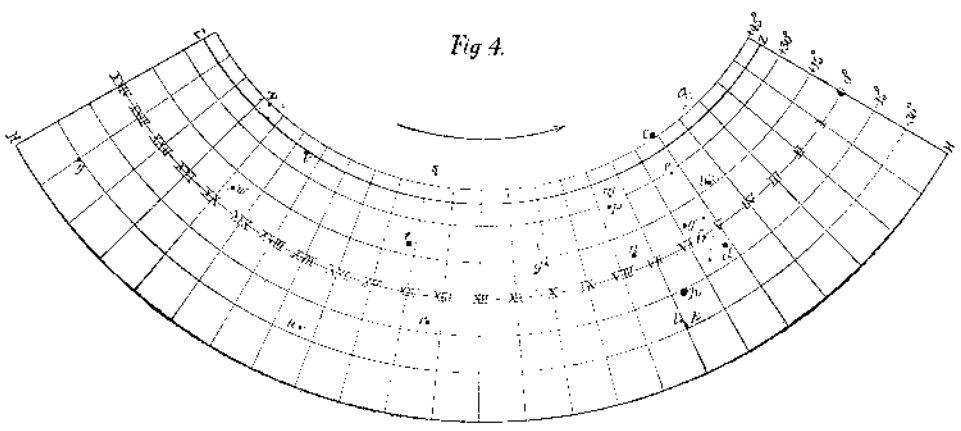
The following plan of a study of the heavens is offered for the assistance of the non-professional student, who finds his chief difficulty in the constantly changing positions of the stars from day to day; an apparent but not real change, due to the revolution of the earth round the sun.

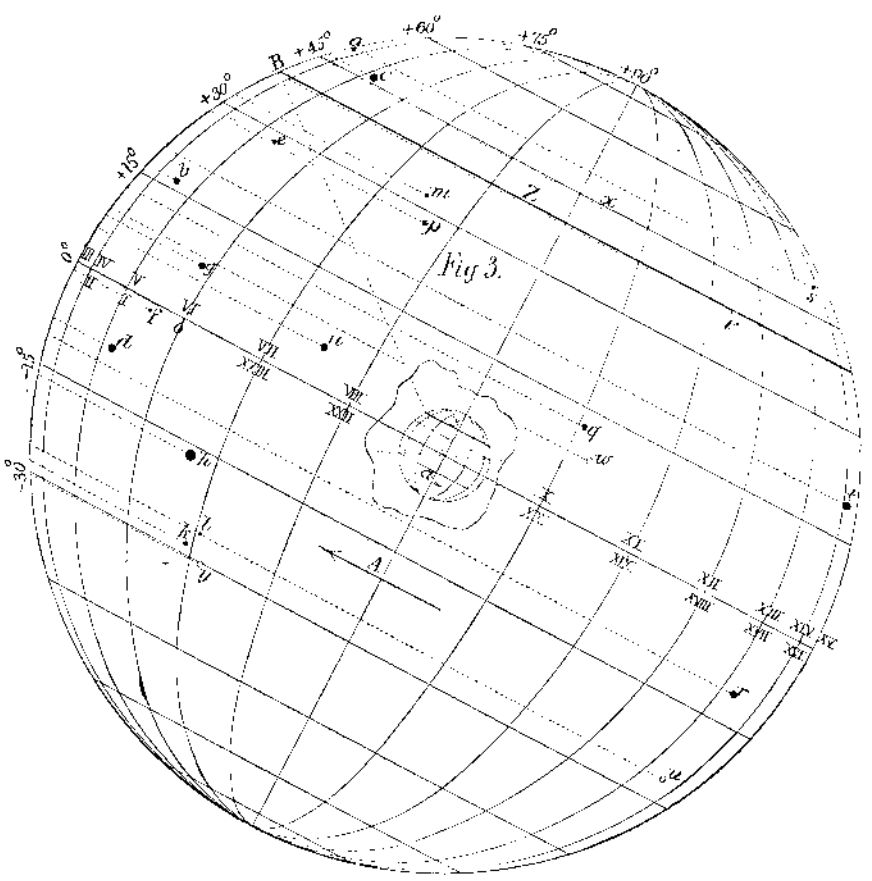
Omitting a very small fraction, the length of the year is 365¼ days. During this period the earth rotates on its axis 366¼ times; i. e., the year is composed of this number of sidereal days, or the same star comes to the meridian this number of times, while the sun crosses it only 365¼ times.

This will be made clear by the following illustration: If the earth's orbit were a circle, its axis perpendicular to the plane of the ecliptic; and if it revolved at a uniform rate, Fig. 1 would represent it in twelve positions, with the understanding that the earth's diameter is enormously exaggerated to make the illustration clear.

Assuming the length of the year to be 360 days, each month having 30 days, the earth in the figure is represented at intervals of one month. While it is moving from position *I* to *II*, i. e., through 30 deg. of its orbit, it must rotate on its axis this number of degrees (from *a'* to *b*) in addition to the thirty rotations it performs during the month to bring the sun *S* on the meridian.







HOW TO STUDY A STAR MAP.

The earth each day rotates on its axis 361 deg.; therefore in 360 days it rotates 360 × 361 deg., and 360 × 361 deg. ÷ 360 deg. = 361 rotations during the year.

A star is always seen in directions indicated by the arrows, i. e., along lines which are practically parallel. If the reader will follow the earth in its consecutive positions, he will see that a star comes to the meridian at intervals of exactly one rotation of the earth, while the sun reaches it 1/360 of a rotation later.

During one complete revolution of the earth round the sun, i. e., after 360 solar days, the earth will have made relative to the stars (360 × 1/360) = 1 rotation more than the number of days indicates. The fact that the solar year is composed of 366¼ sidereal days does not complicate the discussion.

If this were all, it is evident that each solar day the earth would rotate a little less than 361 deg. But the earth's orbit is an ellipse of small eccentricity, and while its axis moves parallel to itself it is inclined at an angle of about 23½ deg. to the vertical—a consideration of which would involve the subject of the "equation of time," a discussion which is outside the scope of this article.

The other point to which attention is called is illustrated in Fig. 2. The differences between the distances of the stars need not distract the attention of the observer of the heavens. For the purposes of observation they may be regarded as situated upon the internal surface of a sphere whose diameter compared with that of the earth is so great that the latter may be represented by the point *E*.

Let *s* represent the nearest fixed star. A circle described with *E s* as a radius represents the "celestial sphere," upon whose surface all the stars may be considered to be located.

Thus a star, *A*, is represented at *a*; *B* at *b*; and *C* at *c*.

The positions of a few of the bright stars are indicated in Fig. 3, which shows the celestial sphere with meridians or "hour circles" traced upon its surface, and "parallels of declination" at intervals of 15 deg. The earth is shown within it very much enlarged. In the drawing it would shrink to a mere point if it were drawn to the same scale as the celestial sphere. The parallel represented by the heavy line *z* is that of Washington. The radial line produced to intersect the celestial sphere determines the position of the zenith of Washington; and the parallel of declination represented by the heavy line *Z* may be called the zenith-parallel of Washington; i. e., as the earth rotates on its axis, each point of this parallel becomes in succession the zenith.

The earth rotates in the direction of the arrow *a*, while the celestial sphere remains stationary. It is convenient, however, to regard the earth as stationary, and to consider that the celestial sphere revolves in the opposite direction, viz., that of the arrow *A*.

If the reader will consider that when his body is erect it forms a continuation of the earth's radius, he will realize that the point *B* is directly overhead, or his zenith. If he will turn his back to the Pole star and look directly south, he will be in a position to observe the majority of the stars which are labeled and indicated in the figure, and whose names—which may be found in the Nautical Almanac—are given in the table below.

The celestial equator, whose plane coincides with that of the earth, is divided into twenty-four equal parts numbered from 0 to XXIV. The numbering 0 begins on the far side or invisible surface of the celestial sphere, and the numbers I and II. are also invisible in the drawing.

The visible divisions are from III to XV; they are then continued on the invisible surface until XXIV or the 0 point is again reached. This arrangement of the drawing has been made to bring as large a number of bright stars as possible on the surface of the visible portion of the celestial sphere. They are represented by small black circles.

Those which are on the far or invisible side are represented by small open circles. By this arrangement seventeen of twenty-two bright stars are black, and the remaining five are open circles.

The "right ascension" of a star is the hour angle indicated by the Roman numerals on the celestial equator, and the "declination" the number of degrees measured on the hour circle which passes through its right ascension point; i. e., right ascension may be regarded as celestial longitude, and declination as celestial latitude.

For example, the declination of every point of the heavy line *Z*—the zenith-parallel of Washington—is 38 deg. 55 min. 14 sec., and the heavy line *z* is the parallel of Washington whose latitude is also 38 deg.

55 min. 14 sec. The declination of Vega (marked *v*) is 38 deg. 41 min. plus; therefore this star is less than ¼ deg. south of the zenith, i. e., almost exactly overhead when it crosses the meridian.

If the observer will turn his back to the pole of the heavens, and look directly south, the celestial sphere will appear to revolve from the east to the west, i. e., from his left toward his right. The highest point of the celestial equator is about 51 deg. above the horizon. Each of the twenty-four hours of right ascension is represented by 15 degrees. The degrees of declination on one side of the equator are marked plus, and those on the other side minus.

Comparing the illustrations in Fig. 3 with the right ascensions and declinations given in the table, it is easy to become familiar with this method of locating a star on the celestial sphere.

If the conditions assumed in Fig. 1 were true, every star would come to the meridian exactly four minutes earlier each day, and four minutes multiplied by 360 (360 × 4 ÷ 60) = 24 hours.

It is then clear that the sidereal day being shorter by four minutes than the solar day, 361 of the former would be equal to 360 of the latter. But there are actually 366¼ sidereal days to 365¼ solar days. Dividing one by the other, 366.25 ÷ 365.25 = 1.002738; and 1.002738 — 1.0 = 0.002738, the excess of the length of the solar day over that of the sidereal day. Reducing this to minutes and seconds, 0.002738 of a day = 3m. 56.5s. The sidereal day is then three minutes and fifty-six and a half seconds shorter than the solar day.

If the months were of the same length, we should be able to say that the same star crosses the meridian exactly two hours earlier on the same day of each succeeding month.

Fig. 4 is a map of that portion of the heavens which contains the stars whose positions on the celestial sphere are shown in Fig. 3. If the observer will place himself in the position already described, the heavens will appear to move in the direction of the arrow; and during a single night he will be able to identify several bright stars.

The heavy arc *Z Z* marks the zenith-parallel, and the arc *H H* the horizon. The distance between the zenith and the horizon (= 90 deg.) may be roughly divided by the eye, and with the aid of the map a conspicuous star may be located.

In observing the stars α Persei (*a*); α Aurigæ or Capella (*c*); η Ursae Majoris (*s*); and α Cygni (*x*), the observer should face the pole, as these stars cross the meridian a little north of the zenith. The observation of Capella which is very near the zenith will assist very much in identifying a large group of stars, including the magnificent constellation Orion and the Dog Star Sirius (*h*). Capella crosses the meridian about forty minutes after Aldebaran (*b*); and these are followed by some of the brightest stars in the heavens. Some knowledge of the positions of these stars makes it a comparatively simple matter to use a star map, and thus to command a fair knowledge of the heavens in detail.

Vega (*v*) is very near the zenith when it crosses the meridian early in the evening in September. Its right ascension is between XVIII and XIX. It is followed a little over an hour later by Altair (*w*) which is about a third of the distance between the zenith and the horizon.

Next in order is α Cygni (*x*) which is a little north of the zenith, and can be seen by facing the pole, and a little over two hours later Fomalhaut (*y*), less than one-fourth of the distance from the horizon to the zenith, will cross the meridian.

TABLE.

Name.		Right Ascension.		Declination.	
		Hrs.	Min.	Deg.	Min.
α Persei	(*a*)	3	17 +	+ 49	31 +
α Tauri or Aldebaran	(*b*)	4	30 +	+ 16	19 +
α Aurigæ or Capella	(*c*)	5	9 +	+ 45	54 +
β Orionis or Rigel	(*d*)	5	10	— 8	18
β Tauri	(*e*)	5	20 +	+ 28	31 +
ε Orionis	(*f*)	5	31 +	— 1	15
α Orionis or Betelgeuse	(*g*)	5	50 +	+ 7	23 +
α Canis Majoris or Sirius	(*h*)	6	41	— 16	35
ε Canis Majoris	(*k*)	6	54 +	— 28	50
δ Canis Majoris	(*l*)	7	4 +	— 26	14
α² Geminorum or Castor	(*m*)	7	28 +	+ 32	5 +
α Canis Min. or Procyon	(*n*)	7	34 +	+ 5	27 +
β Geminorum or Pollux	(*p*)	7	39 +	+ 28	15 +
α Leonis or Regulus	(*q*)	10	3 +	+ 12	25 +
α Virginis or Spica	(*r*)	13	20 +	— 10	40
η Ursæ Majoris	(*s*)	13	43 +	+ 49	46 +
α Bootis or Arcturus	(*t*)	14	11 +	+ 19	40 +
α Scorpii or Antares	(*u*)	16	23 +	— 26	13
α Lyræ or Vega	(*v*)	18	33 +	+ 38	41 +
α Aquilæ or Altair	(*w*)	19	46 +	+ 8	37 +
α Cygni or Deneb	(*x*)	20	38 +	+ 44	56 +
α Pis. Austr. or Fomalhaut	(*y*)	22	52 +	— 30	7

There are now more than 750 motor omnibuses in London. Eighteen months ago their number was under fifty. No fewer than 184 million passengers are, it is said, now being carried annually.

A HYDRAULIC AIR-COMPRESSING PLANT.

One could scarcely conceive of a more direct method of seizing the power of a stream and coverting it into a more flexible form of energy for distribution to various points of application than that employed at the Victoria mine in the northern part of Michigan. The mine is located near the Ontonagon River, the power of which is converted into compressed air, and with this the machinery and tools of the mine and the mill are operated. However, instead of using turbines, as is ordinarily done, to convert the hydraulic into mechanical power, and then using compressors to transform the mechanical into pneumatic power, in this system the air is compressed directly by the water, and without any intermediate mechanism. The action is similar to that of the aspirator pump, in which, as is well known, a current of water acts by adhesion to exhaust the air from a receptacle. In the present case the reverse takes place, for bubbles of air are taken from the free atmosphere and then trapped in a chamber.

The hydraulic system of compressing air is not new, even as a commercial enterprise. In the SCIENTIFIC AMERICAN of April 8, 1900, we described a plant of this character installed at Magog, Quebec, to furnish power for the Dominion Cotton Mills Company. Several other hydraulic compressors have since been established. However, the plant of the Victoria mine, aside from being one of the largest of its type ever built, possesses a number of very novel features which are most interesting.

A concrete dam has been built across the Ontonagon River, at a point 4,000 feet above the plant, and thence water is conducted through a canal under a head of 71 feet. At the forebay of the canal three shafts have been sunk through solid rock to a large subterranean chamber. These shafts are fitted with intake pipes 5 feet in diameter sealed in with concrete. The chamber is 281.5 feet long, 18 feet wide, and 26 feet high. At the end opposite the intake pipes it terminates in a tunnel 10 feet high and 18 feet wide, communicating with a large shaft 18 x 20 feet in cross section, which leads to the tailrace. The chamber collects the air, which is sucked down by the water pouring down the intake pipes. The air is here held under a compression of 114 pounds gage, due to the difference between the water level in the chamber and the tail-water level. Under normal conditions this difference in level amounts to 271 feet, while the vertical distance from the water level in the chamber to the level at the top of the intake pipes is 343 feet. Hence, the total working head, from intake to tailrace, is 72 feet.

A receiving tank is built over each intake pipe. Within this tank, and mounted on the upper end of each pipe, is an intake head consisting of an annular funnel. The funnel is arranged to telescope over the end of the pipe, and is normally supported on a floating bell or inverted tank, which serves to hold the mouth of the funnel just below the level of the water. Around this funnel, and also supported on the bell, is an annular air tube, which is supplied with air by means of feed pipes extending well above water level. This annular tube is fitted with series of small tubes, which project radially inward into the mouth of the funnel. The tubes are only ⅜ of an inch in diameter, and there are 1,800 of them for each intake head. The water flowing into the funnel over these tubes acts, on the aspirator principle, to draw air from them in bubbles, which are carried to the chamber below. At the bottom of the shaft the intake pipe is somewhat flared, and extends about 15 inches below the normal working level of the water in the chamber. Directly below each pipe is a conical concrete block, as shown in one of the illustrations. The water striking this block is spread out in an annular stream, thus delivering the air bubbles near the surface of the water. During the comparatively slow passage through the chamber, the air bubbles, owing to their buoyancy, rise out of the water and are trapped, because the water level in the chamber is 18 inches above the roof of the outlet tunnel. The water, however, continues out through the tunnel and up the inclined shaft, whence it discharges into the tailrace.

The compression chamber above the normal level of the water therein has a capacity of 80,264 cubic feet. A 24-inch pipe conducts the air to the various pneumatic machinery used in the mine. In order to prevent an excess of compression, a small blow-off pipe is provided, which leads up to the bell that supports the intake head of the central pipe. The lower end of the blow-off pipe is submerged to a depth of a few inches below the normal level of the water in the chamber. When the pressure becomes excessive, the water is depressed, uncovering the mouth of the blow-off, and permitting compressed air to rush up this pipe into the bell. The latter is then buoyed up by the air, lifting the intake head out of the water, and thus preventing further inflow until the compression has been reduced. In addition to the small blow-off, a larger blow-off pipe, 12 inches in diameter, is provided, which leads to the tailrace. The mouth of this blow-off is submerged to a somewhat greater depth than that of the small pipe, and when the water in the chamber is sufficiently depressed, air discharges through the blow-off, carrying with it a quantity of spray, which shoots out like a geyser to heights of from 150 to 700 feet. This artificial geyser presents a most pleasing spectacle, particularly in winter time, when the spray freezes and forms huge icebergs about the discharge nozzle.

When all three of the intake pipes are in operation, a total of 5,000 horse-power is available. However, one intake pipe has been found to furnish all the power necessary for operating the machinery of the mill and mine. With this single intake, while delivering 11,930 cubic feet of air per minute at an absolute pressure of 128 pounds, an efficiency of 82 per cent is shown. A turbine operating with a loss of 10 or 12 per cent may be considered remarkably efficient; but before this mechanical power can be converted into compressed air, a loss of at least 30 per cent more must take place. The remarkable efficiency of the direct hydraulic compression is thus made apparent; but we should also take into calculation the remarkable economy of operation; for the hydraulic compressor contains no machinery which requires attention or is liable to become deranged.

As was stated in our previous article on the hydraulic compressor, one of the chief advantages of this system is the fact that the compression is isothermal. As the bubbles of the air are carried down the intake pipe they are compressed, but the heat of compression is conducted off by the water which surrounds them. In the ordinary systems of compressing air a great deal of difficulty is experienced, owing to the increase of temperature due to the compression, and also owing to the condensation of water vapor which occurs with a fall of temperature, or an increase of pressure, or both. However, the air which is trapped in the rock chamber at the Victoria mine is of a temperature almost as low as that of the water, and is practically free from moisture.

Correspondence.

Gyroscopic Resistance of Motors on Railroad Curves.

To the Editor of the SCIENTIFIC AMERICAN:

One point in the cause of the New York Central wreck which I have not seen mentioned, and which appears to me to be of possible importance, is the gyroscopic action of the motors on the electric locomotives. When one considers how stubbornly a toy gyroscope of only a few ounces weight will resist deflection from its plane of rotation, what must be the stress required to deflect from tangent to curve, at express train speed, the heavy revolving motors of a powerful locomotive? C. H. KENNISON.

Ayer, Mass., March 4, 1907.

[One effect of the gyroscopic action of the rotors and wheels of an electric locomotive would be to resist the angular movement round a curve; but since at express speed it would take from 20 to 30 seconds to turn the locomotive through 90 degrees of a 3-degree curve, this resistance would be insignificant compared to the other resistances encountered.—ED.]

Tornadoes in Kansas.

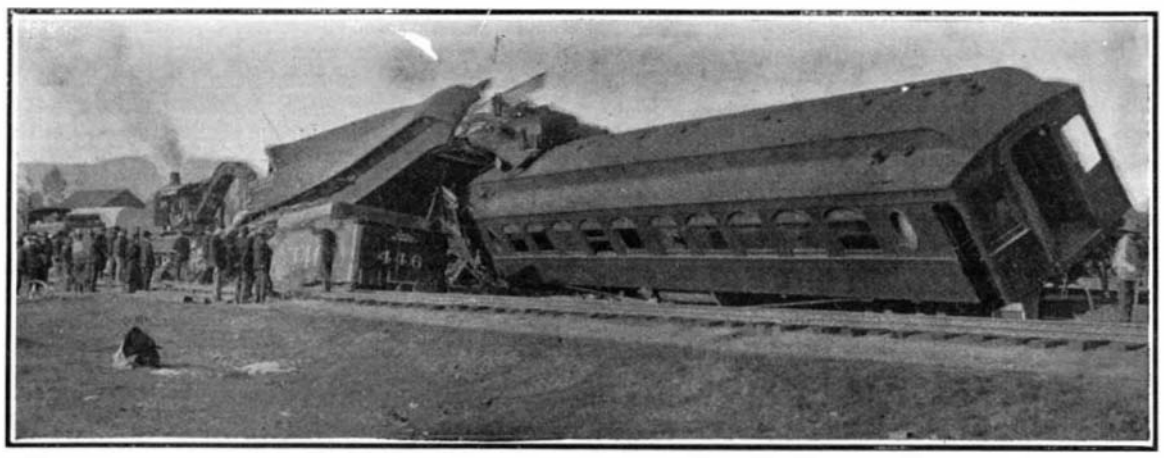
To the Editor of the SCIENTIFIC AMERICAN:

While in Kansas a few years ago I had a very clear view of a tornado. It was about ten miles distant, passing swiftly over the prairie. It presented the appearance of a long rope about two feet in diameter. It extended from a dark, irregularly-shaped cloud to the earth, and was slightly curved. It was of nearly uniform thickness, and leaned about 35 deg. from a perpendicular toward the cloud. A line drawn from where I stood to the cloud would have made an angle of about 40 deg. with the earth's surface. After this rope-like projection had parted, I noticed in the irregular cloud a perfectly-shaped spiral of silver whiteness. It was shaped like a great auger, and extended from the point where the funnel or rope had been connected with the cloud forward in the direction the cloud was moving. All around it was in wild commotion, but the spiral itself seemed to stand like a great white ribbon coiled auger shape and fixed secure. This spiral, at the time I caught sight of it, was lying in nearly a horizontal position; the forward end being only slightly elevated. I have never met anyone who has seen this spiral in the tornado cloud; but by one who came dangerously near being caught by a passing tornado, I was told that the center of the whirling funnel was as white as milk. From his statement, taken in connection with my own observations, I have formed the opinion that the center of all tornadoes is a perfectly-shaped electrical spiral, and that when in operation it connects the earth with the cloud. It is manifest that such a spiral would give the middle of the tornado funnel a white appearance. But it is not likely that one looking at it in its upright form would detect its spiral form. Indeed, it would have to turn itself in a most favorable position in order to reveal to the eye of the observer its spiral form.

La Porte, Tex., February 26, 1907. W. T. HALL.

WOODEN CARS IN A RAILROAD WRECK.

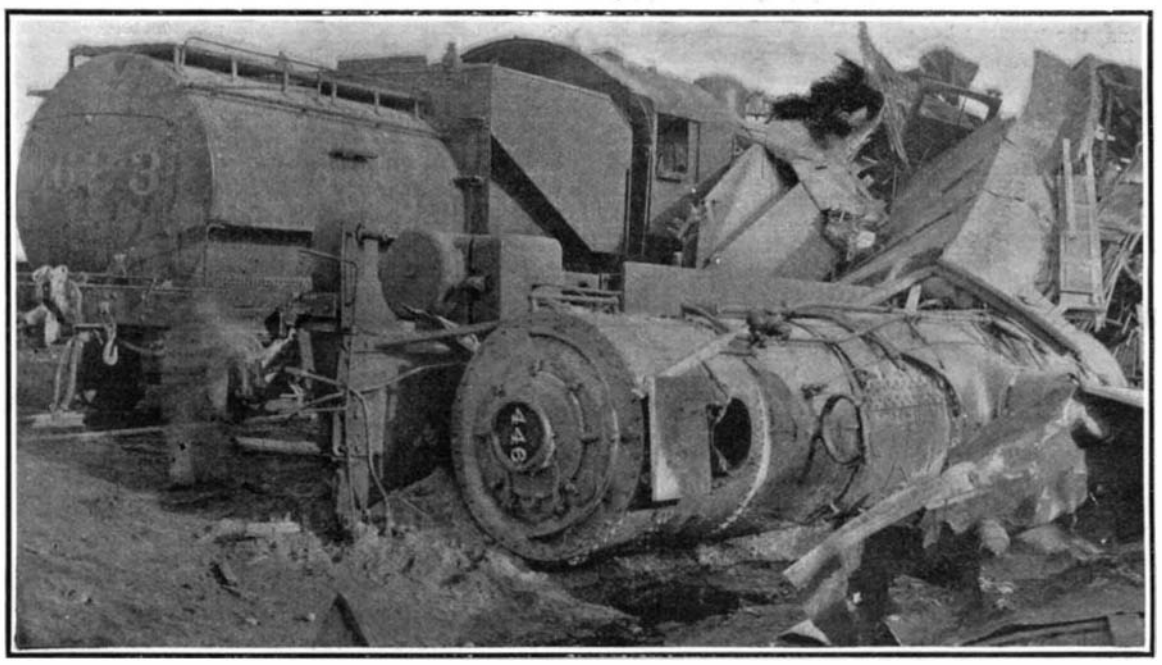
As a general rule, the SCIENTIFIC AMERICAN publishes photographs of railroad wrecks only when there is some definite lesson taught by the disaster. The accompanying photographs of a wreck which occurred on the first of March near Colton, Cal., on the Santa Fé Railroad, tragically illustrate both the ever-present peril of the open switch and the frailty of the ordinary wooden passenger car, when it is placed between a heavy locomotive and a heavy Pullman car, and the train rushes at high speed into a head-on collision. In the present case, a passenger train, which was made up of a baggage car, a smoker, a vestibule day coach, and a Pullman observation car, was running at a speed of about fifty miles an hour as it approached a siding onto which a freight train had just backed, in order to give the passenger train a clear track. The train crew of the freight, by one of those fatal lapses of memory which are such a frequent cause of railroad disaster, omitted to close the switch, and the engineer of the passenger train failed to notice that it was open, until he was almost upon it. The centrifugal force as the engine attempted to swing around the sharp turnout was sufficient to overturn it bodily upon its side, and it ground its way over the roadbed for 150 feet before it came to rest, the tender breaking away at the point where it left the tracks. The train swept by the overturned locomotive and collided, practically at full speed, with the heavy engine of the freight train. The momentum of the vestibule day coach and the observation car drove the smoker into the baggage car and, as will be seen from our photographs, literally ground these two into fragments, the wreckage being more complete than anything we remember to have witnessed in a wreck of this character. Extraordinary to relate, only one person was killed outright, although two others were probably fatally injured, and a large number received minor injuries.



The Massive Vestibuled Day Coach Crushed the Baggage and Smoking Cars into Fragments, but Itself Remained Practically Intact.

This wreck calls attention once more to the ever-present danger which exists in facing switches, which, while they may be eliminated on two-track roads, cannot be on single-track roads, on which the traffic runs in opposite directions on the same rails. Facing switches can be got rid of only by double-tracking, and the frequent occurrence of accidents of this kind proves that on the transcontinental roads, on which fast heavy expresses are run, double-tracking has become and, indeed, has long been, an urgent necessity. It is certain, however, that greater precautions could be taken to safeguard such switches. The provision of the present small dwarf signal, only a few feet high, at the switch points is a miserable and utterly inadequate safeguard. Not only should the switch signals be mounted on a lofty signal post, but a lofty, distant signal should be provided, and the two so connected that when the switch is open, both signals will show a red semaphore by day and a red light by night. If a clear distant signal were provided, as it unquestionably should be, we believe that accidents due to express trains, or indeed any kind of train, running into open sidings would become exceedingly rare.

The other lesson of the wreck is that the wooden day coach is literally a death trap in collisions, and cannot be too quickly superseded by the car of all-steel construction. To be convinced of this, it is only necessary to contrast the splintered wreckage of the frail smoker and baggage car with the practically intact under-frame and body of the vestibule day coach, whose more massive construction seems to have suffered practically no injury, not even the glass of the windows being broken. That both the vestibule day coach and the observation car were subjected to terrific shock was shown by the fact that in both of them the momentum of the seats was sufficient to tear them from the floor and pile them in a heap at the front end of the car. Here, by the way, is a menace to passengers which could very easily be remedied, and at little cost to the railroad companies. Ordinarily, the seats are merely screwed down to the flooring with wood screws, and undoubtedly the breaking away of the seats and the crowding of seats and passengers in a confused mass at the front end of the car is the cause of many severe fractures and contusions. Cast-iron legs and frames should be abolished, and replaced by light steel framing with the legs bolted, not screwed, to the floor.



To the Right Is the Engine of Express; to the Left the Tender of the Freight.

TABLET WRITINGS FROM THE RUINS OF NIPPUR.

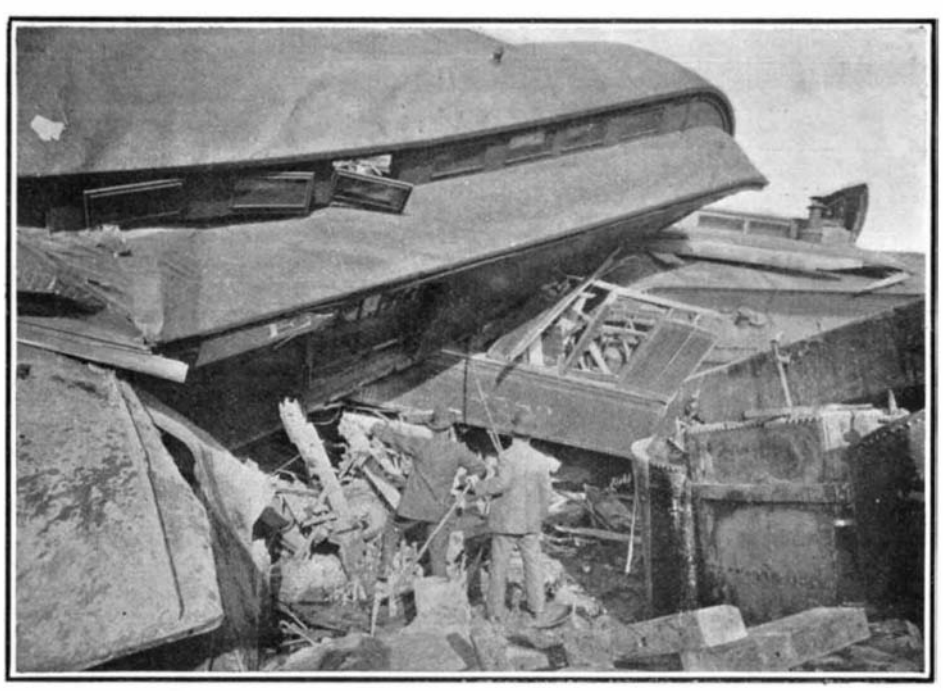
BY H. D. JONES.

The expedition sent out by the University of Pennsylvania has uncovered and freed from the dust of ages one of the most interesting archives ever rescued from the debris of a buried city. Fourteen centuries before the birth of Christ, under the foreign rule of the Cassite kings of Babylon, Nippur became one of the most highly civilized and enterprising cities of ancient times. During this period of its prosperity, and before the hand of destiny consigned it to decay, Nippur must have been a highly desirable place of residence. Among the fine buildings were a temple and a temple school, from the executive department of which the archives referred to have been obtained. The "library" consists of about twenty-five thousand books and documents in the form of the clay tablets of the time, and the deciphering of these discloses many conditions not very different from those obtaining in Philadelphia to-day.

After years of study Prof. Clay, of the University of Pennsylvania, who has been described as "probably the foremost living copyist of cuneiform tablets," has succeeded in translating many of the important tablets in the collection. The clay tablets were found, it may be mentioned, in one of the ancient palaces unearthed by the workers, and were in perfect condition for the most part, because they had evidently been "filed away," if the expression can be applied to such ancient objects, the clay tablets being placed on edge, "reclining against each other like a shelf of leaning books in an ill-kept library of to-day."

Astute Arabs, rightly guessing that there were some monetary pickings in the relics that the members of the expedition sought in the ruins of Nippur, took a

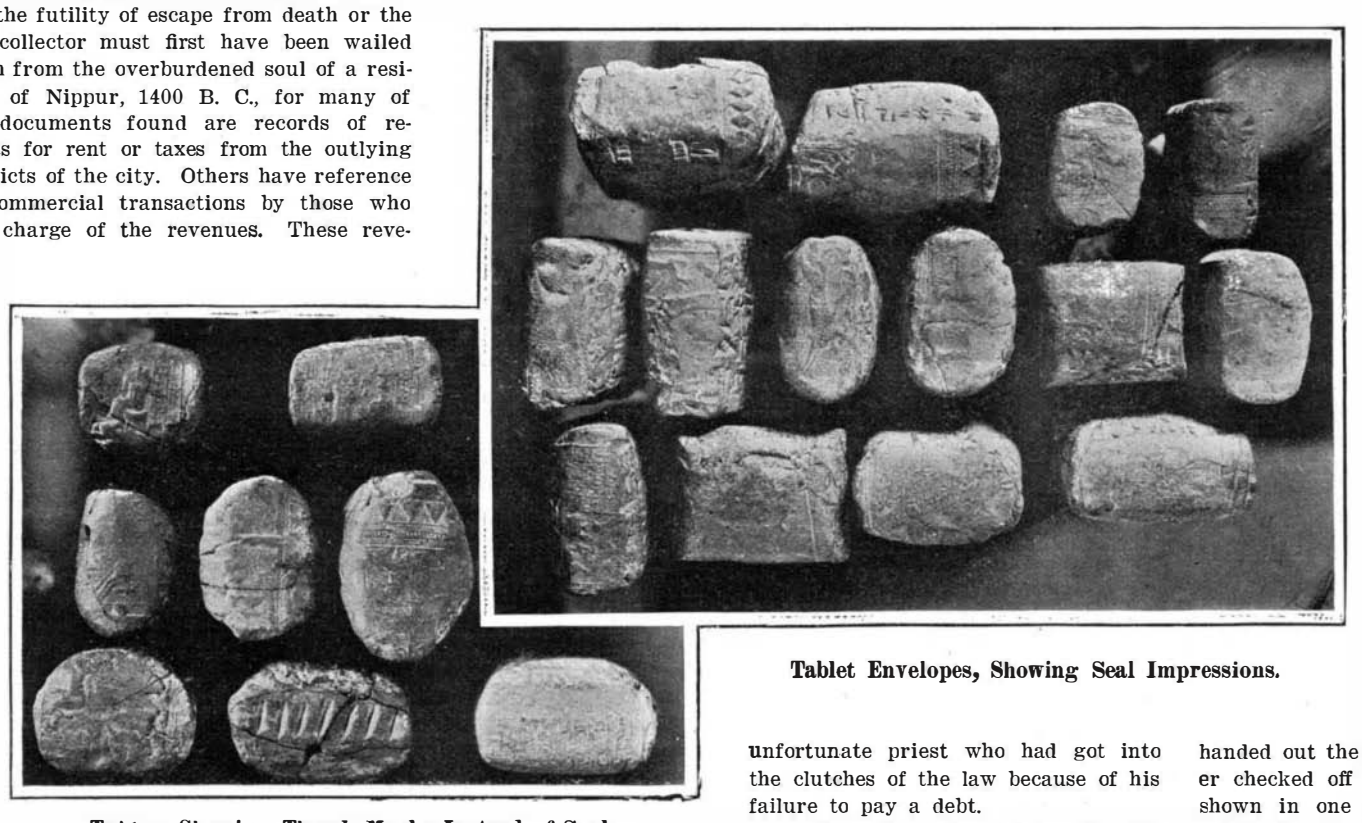
Wreckage of Baggage and Smoker After They Were Crumpled into Fragments Between Vestibuled Coach and Freight Engine.



Roof and One Side of Baggage, and Fragments of Smoker Immediately After Collision. These Adjoining Views Taken on Opposite Sides of Wreck.

WOODEN CARS IN A RAILROAD WRECK.

sly hand in the work, and through their reprehensible operations a number of tablets found their way to New York in the possession of private individuals. Some of these were deciphered with far too much airy freedom by the translator, but Dr. Clay has corrected errors in the interpretation of the signs on these tablets, so that the Babylonian data now in the possession of the University of Pennsylvania are as complete as care can make them. From the tablets translated by Dr. Clay it would seem that the saying regarding the futility of escape from death or the tax collector must first have been wailed forth from the overburdened soul of a resident of Nippur, 1400 B. C., for many of the documents found are records of receipts for rent or taxes from the outlying districts of the city. Others have reference to commercial transactions by those who had charge of the revenues. These revenues were loaned out in the interest of the temple exchequer, the priests being very careful to charge interest on the money advanced. Still others record the payment of salaries to priests and to officials of the storehouse.



Tablets Showing Thumb Marks Instead of Seals.

Tablet Envelopes, Showing Seal Impressions.

The Payroll of the Officers and Servants of the Temple of Bel at Nippur.

The taxes were paid, not in coin, but in natural products, such as corn, sesame, oil, dates, flour, and live stock. Although no record has been found to show the relative value of these articles, there was doubtless a regular rate of exchange in Nippur for the product of the farmer's toil. In most instances where the bookkeepers of Nippur recorded the payment of taxes, a note was made of the purpose for which it was paid. Thus one tablet states that grain was handed in for the maintenance of the priest, the temple servant, and the storehouse servant. Other payments are recorded as for the temple gateman, the singer, the temple shepherd, and for sacrificial purposes.

According to Dr. Clay, the records of the tablets show that in this ancient town, the temple of the god was not only the foremost institution of the city, but that it practically supported and controlled everything in the immediate vicinity.

They were careful bookkeepers in Nippur fourteen centuries before the birth of Christ, for these tablets also show plainly not only the nature of the tax collected, but the town from which it was received. In these outlying places the taxes were either transferred to Nippur or used in local civic disbursements—a complicated and unwieldy system of collecting and distributing revenues, when it is remembered that the taxes were paid in either grain or cattle.

Many of the tablets are records of business transacted between private individuals, and some of these are intensely interesting as throwing light on the life of the inhabitants of this ancient city. For instance, one self-sacrificing citizen, according to the chronicle of the tablets, took the place in a prison cell of an unfortunate priest who had got into the clutches of the law because of his failure to pay a debt.

A wise ruling revealed by the tablets is a case in which the concomitants are a farm crop, an ox with a broken leg, and a borrower who subsequently became a sorrower. The man who borrowed the ox obtained it from a farmer, who stipulated that the animal should be returned at a certain time, so that the work on his own farm should not suffer in consequence of his generosity. The borrower was unfortunate in that the ox broke a leg while working for the new driver, and in consequence the time for the return of the animal, which was the essence of the new arrangement, came and passed and the owner of the ox was unable to work his farm. The tablet shows that the borrower was compelled to make good the crop that would have been raised by the owner of the ox, had he not been deprived of the use of his animal by the chapter of accidents related.

For a time it puzzled the translator of these tablets to know the meaning of little indentations, apparently made with a pointed instrument, by the side of the columns of record of disbursements made. It has been decided that these were the check marks of the person who made the payments. In modern parlance, as he handed out the pay envelope the Babylonian bookkeeper checked off the amounts on the tablet in the way shown in one of the photographs, by making little impressions alongside the amount or name.

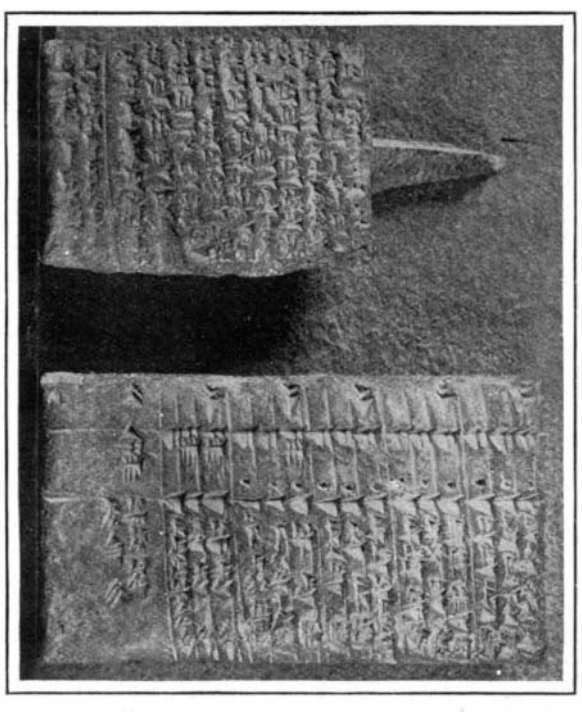
The use of the seal was all-important in the transactions of the business man of Nippur. It was an easy matter to forge a document drawn on one of the clay tablets, so the method employed to prevent this was to incase the tablet in a sealed envelope. Of these seals Dr. Clay says:

"The seal impression is equivalent to the signature of the modern document. It belongs to the man upon whom the obligation rests, or who is the recipient mentioned in the tablet, or to whom the goods are delivered. The only way that protection could be assured was to incase the tablet, and for the obligor to make impressions with his seal upon the envelope. The holder of the document might be able to make changes on the case, but he could not remove it to alter the tablet because he could not restore the envelope which bore the impress of the seal of the obligor."

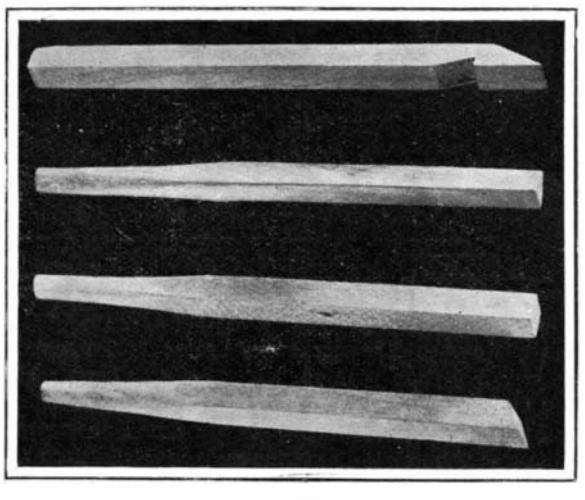
Frequently instead of a seal there was a thumb mark, showing that the Babylonians were alive to the importance of the method of identification so widely exploited in the present day as an unerring means of connecting the mark with the originator.

Apart from the tablets themselves the most interesting thing about the ancient writing is the way in which it was done. There has been some controversy concerning the shape of the stylus used by the ancient scribe in forming the characters on these clay tablets. Dr. Clay has made several of these after the pattern

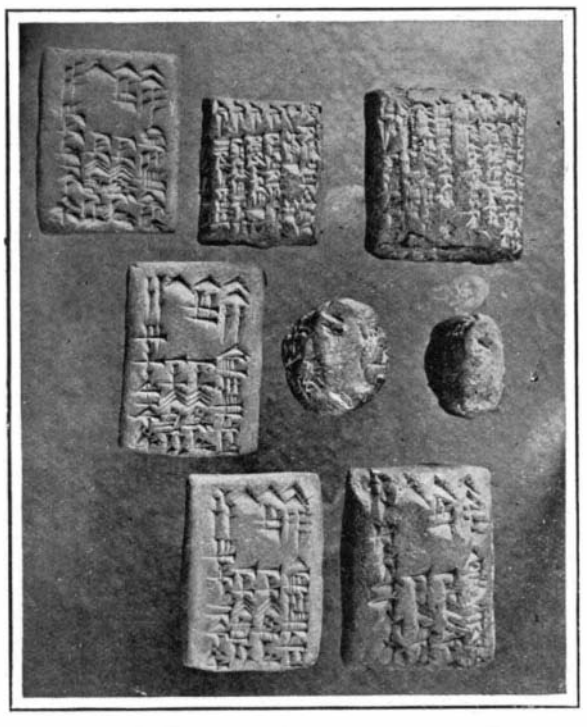
How the Stylus Was Used in Writing the Tablets.



A Payroll Showing the Marks Where the Items Were Checked Off by the Bookkeeper.



Supposed Forms of the Stylus as Reconstructed To-Day.



Original Tablets, Tablet Envelopes, and Modern Replicas.

TABLET WRITING FROM THE RUINS OF NIPPUR.

on which he believes the originals were constructed. Some of these are shown in the accompanying illustrations. None was found in the ruins. The manner in which these writing instruments were used is also shown in one of the engravings herewith.

CARBORUNDUM AND SILICON DETECTORS FOR WIRELESS TELEGRAPHY.

BY A. FREDERICK COLLINS.

A novel detector for determining the presence of electric waves, has just been brought out by General H. H. C. Dunwoody, and has been found sufficiently sensitive and trustworthy to be used for commercial wireless telegraphic work.

The device in question consists of a minute mass or fragment of carborundum—an artificial compound made of carbon and silicon in the electric furnace—held in place between two metallic terminals or conductor plugs, usually formed of copper or brass.

This detector has recently been made the subject of exhaustive tests by Mr. G. W. Pickard, who has found that it is somewhat less sensitive than the magnetic detector of Marconi, which in turn follows the electrolytic detector of Fessenden; that is to say, while it requires from 350 to 400 micro-ergs (1 micro-erg being 1/1000 of an erg*) to operate the electrolytic detector, and from 400 to 500 micro-ergs to impress a magnetic detector, it requires between 9,000 and 14,000 micro-ergs to carry the conductivity of a carborundum detector so that it will produce an audible tone in a telephone receiver, with about the same amount of energy required by a microphone detector.

Notwithstanding this very considerable difference in the sensitiveness of the electrolytic and carborundum detectors when measured in the C. G. S. system of units, in the actual practice of wireless telegraphy the difference in receptiveness is barely perceptible over similar distances. In the first experiments with carborundum as an electric wave detector, it was found that its sensibility to the electric oscillations set up in the circuit of which it was a part, was a maximum when a certain critical potential prevailed in the local circuit of which it also formed a part.

In this respect it resembles the electrolytic detector when in action. For this reason a potentiometer or variable resistance is used in shunt with the detector. As carborundum is obtained in the form of crystalline masses, it has, in consequence, a very high resistance where the current flowing in the internal or dry cell circuit is small, but as the strength of the current is increased the resistance drops very rapidly.

Various curves have been plotted showing the resistance variation against the difference of potential across the conductor plugs of the detector, and in one of these it was demonstrated that the conductive charge occurred most rapidly between 1.0 and 1.1 volts. The conductance of the detector at this potential was about 250 microhms, or 0.4000 ohm, and a variation of 0.01 volt at the above potential value will produce a change in conductivity of about 10 microhms, or 4 per cent.

It is well known that the flat side of carborundum is a very poor conductor and in order to obtain good electrical contact, the sharp edges of the carborundum fragment must be clamped between the opposed surfaces of the plug ends of the detector, when the actual contact is limited to an exceedingly small area—not more than one millionth of an inch and probably less.

In common with the Fessenden hot-wire barretter and responders of the bolometric type, the action of the new Dunwoody detector is purely thermal. But instead of utilizing either an exceedingly fine metal wire of relatively low specific resistance and temperature coefficient, as does the barretter, or a large radiating or absorbing surface in proportion to its mass as does the bolometer, the carborundum detector employs a constricted current path lying along the edge of the crystal in contact with the oppositely-disposed surfaces of the conductor plugs.

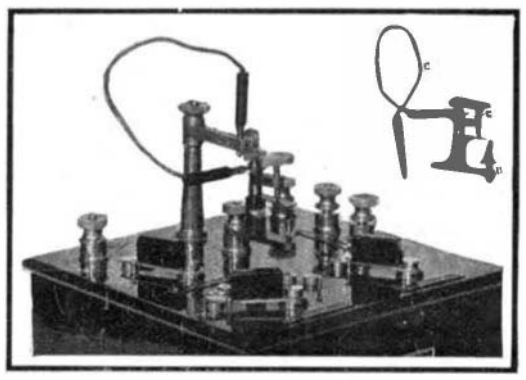
The new carborundum detector is so designed that it can be inserted in circuit with a De Forest receptor instead of the detector formerly used; in other words, the carborundum detector is made interchangeable with the electrolytic detector, which it has superseded. When placed in such a receiving circuit, the manifestation is greatest when the potential impressed upon the detector is between 1.0 and 1.2 volts.

In other tests, the conductor plugs supporting the carborundum crystals were heated by a spirit lamp, when the resistance of the detector was observed to decrease greatly, but on cooling again it assumed its former resistivity, which is of the order of a megohm.

The crystals of carborundum employed in the Dunwoody detector are microscopically selected and only those having the sharpest edges are chosen, since these have been found to give the best result. The fragment of carborundum is placed between a spring and an adjustable screw plug, and by varying the pressure of the spring by means of a screw the point of maximum sensitiveness can easily be obtained.

The exact proportions of the crystal are not essential and it may vary from one to three millimeters on the side. The crystal to be used should never be touched by the fingers, as this often reduces its sensitiveness to an appreciable extent; the proper way to handle the element is to use a pair of tweezers.

Since the advent of the Dunwoody carborundum detector, Pickard has brought out one using silicon as the sensitive medium. Silicon is a non-metallic element, prepared as a dull-brown amorphous powder, as shining metallic scales or as dark steel-gray granules, sometimes showing crystallization. Any one of these may be used as a detector, and in any case it is pressed into good electrical contact between two conducting plugs as in the ordinary coherer.



THE NEW DUNWOODY CARBORUNDUM DETECTOR INSERTED IN A RECEPTOR.

Different from the coherer, this latest "thermo-electric regenerative detector" converts the energy of the oscillation set up in the receiving aerial, into heat at the junction of the silicon and the metal forming the conductor plugs by virtue of the high resistance of the former and the low resistance of the latter.

The amount of heat developed by the high thermo-electromotive force, and the consequent temperature rise, is proportional to the square of the resistance, according to the well-known law of Joule. The detector gets its name as indicated above from the fact that this thermal energy is converted or regenerated into a direct electric current, the detector performing the same function as all others that have been devised, namely, that of a very delicate relay.

A machine for applying screws at the rate of fifty a minute, if necessary, has recently been placed on the market and consists of a hopper connected by a vertical flexible shaft and tube to the driving mechanism below. The withdrawal of the bit from each screw as it is driven causes a new screw to drop out of a magazine and fall in line with the bit and also allows a screw to fall from the hopper into the magazine. The use of the intermediate magazine was found necessary, as the operation of the machine is so rapid that too much time would be wasted in waiting for it to drop from the hopper. The screws are caused to revolve at the rate of 1,200 revolutions a minute by means of a friction drive so adjusted that the screw stops after it has been driven the required distance.

THE DETECTOR APPLIED TO A DE FOREST RECEPTOR.

* In the C. G. S. system the erg is the unit of work and of energy, being the work done in moving a body through a distance of one centimeter against the force of one dyne, or the kinetic force of two grammes moving at the rate of one centimeter per second.

LEDUC'S ARTIFICIAL PLANTS AND CELLS.

BY DR. ALFRED GRADENWITZ.

A strong reaction against the somewhat childish endeavors of the alchemists to convert one element into another and to generate living beings from inert matter, pervades the history of nineteenth century science. Perhaps we have been prone rather too eagerly to discard the doctrines of former times, banishing many theories which in the course of the last few years have again been found worthy of serious discussion.

We are no doubt at present on the eve of great revolutions in our scientific views; the phenomena of radioactivity have shaken the belief in the immutability of the atom and even the principle of the preservation of matter, at least in its familiar form. Nor does the distinction of three strictly separated states of aggregation stand the test of recent investigation; transitions are found to exist between the different states, and we are warranted in presuming that between the material and the immaterial (the luminous ether) there are likewise numberless intermediary states. Finally there have been discovered transitional stages between inert matter and living beings, from which many interesting conclusions in regard to the nature of life can be drawn.

While Prof. Lehmann's recent researches on apparently living crystals have shown that certain bodies, mineral in outward appearance, behave like living organisms of the lowest type (bacteria), Prof. Leduc, of Nantes, has found the vital functions in animal and vegetable cells to be controlled exclusively by the physical laws of diffusion (osmosis) and cohesion (molecular attraction). On the basis of these phenomena he has even succeeded in artificially producing objects which, not only in appearance but in behavior, closely resemble natural cells, growing, absorbing food, and propagating themselves in exactly the same way.

The botanist might be somewhat embarrassed when asked to incorporate in his familiar system of classes, orders, and families the forms illustrated in Figs. 1 to 4. Still he would hardly have any doubt of their genuineness, their whole aspect being typical of representatives of the vegetable kingdom, especially of certain water plants.

Nevertheless, they are not living beings of any sort, but artificial bodies formed in the laboratory of the chemist. While their very aspect is certain to inspire interest, it is obviously far more interesting to observe them in the making, to watch how from an artificial seed a shoot springs and develops (at a rate readily controlled by the experimenter) into stems, leaves, buds, twigs, ears, and blossoms, and after some time dies like a real plant. The birth and death of a plant can thus be artificially reproduced within the space of a few hours.

Below are given some details concerning the artificial seed and the medium in which it is immersed for germination. A seed one to two millimeters in diameter, consisting of two parts of saccharose (cane sugar) and one part of copper sulphate, is immersed in an aqueous solution containing two to four per cent of potassium ferrocyanide, one to ten per cent of sodium chloride or some other salt, and one to four per cent of gelatine. In this solution, the seed germinates in a few days or a few hours according to temperature; under favorable conditions the germinating process can even be shown as a lecture experiment in a few minutes.

The seed surrounds itself with a membrane of copper ferrocyanide which is permeable to water and to certain ions, but is impermeable to sugar. This semi-permeability produces a high osmotic pressure in the interior of the artificial seed, resulting in the absorption of matter from the surrounding medium and thus in the growth of the whole structure. If the liquid be spread on a glass plate, the growth takes place in a horizontal plane. In a deep vessel, on the other hand, the plant form grows simultaneously in a horizontal and a vertical direction, forming stems which on arriving on the upper surface of the liquid, spread out in flat leaves resembling those of a water plant.

A single artificial seed one millimeter in diameter can thus produce 15 to 20 vertical stems which sometimes reach a height of 25 to 30 centimeters, being either simple or branched, frequently carrying lateral leaves or twigs and terminals shaped like spheres, mushrooms, ears, spires, etc., according to the composition of the culture liquid.

These experiments thus prove that the functions formerly considered as being characteristic of the process of life are due to and controlled by purely physical forces. In fact, the forms in question obviously receive their food by intussusception or internal absorption like living beings, whereas crystals, as is well known, increase by external accretion. Furthermore, the plant forms are really organized, possessing all those organs (stems, leaves, and terminal parts) which are characteristic of plants. As finally the substance used in building up these artificial plants, viz., copper sulphate, rises in stems up to 30 centimeters in height (with a diameter of one millimeter) they are necessarily provided with an apparatus of circula-

tion. Their growth is thus no doubt a real one like that of a plant, a small (artificial) seed developing into a complex form several hundred times larger than itself.

It is further interesting that the products of growth arising from the artificial seed are, like real plants, susceptible to numerous chemical and physical reactions. In fact, their development is arrested by many poisons, while their direction and growth are determined by differences in the internal diffusion pressure and in temperature. However, there are still further analogies between these artificial organisms and real ones. The former, like the latter, are endowed with the power of healing any injury, as whenever a stem is broken before the completion of its growth, the fragments cling to and combine with one another, after which the process of growth again commences. There is only a single function of living plants which has not so far been artificially reproduced, viz., propagation in successive generations. Except for this defect the whole of the vital process of vegetable organisms would have been imitated artificially, at least in its outward appearance; this problem, however, seems to be susceptible of realization like those already solved.

The internal mechanism of the processes controlling the behavior of these artificial plants will be better understood by briefly referring to Leduc's previous experiments.* In these experiments two mutually precipitating solutions—e. g., potassium ferrocyanide and a salt of copper—were sprinkled on gelatine-coated glass. The copper ferrocyanide deposited at the surfaces of contact of the drops formed the envelopes of polygonal cells. Similar cells are formed when potassium solution alone is sprinkled on the gelatine.

During the process of formation the artificial cell is the seat of active molecular motion, consisting of an inward current of water from the moist gelatine and a current of dissolved matter flowing from the center to the surface. This apparent life can be prolonged by maintaining around the cell an environment that will feed it or replace the loss due to diffusion.

These movements are checked by premature drying but recommence on the addition of water, suggesting an analogy to the latent life of seeds and rotifera.

As the ions or constituents of dissolved salts diffuse independently, part of the molecule appears to be assimilated, or fixed in the cell, while the rest is eliminated. A diffusing drop of copper sulphate, for example, leaves at the center a yellow nucleus consisting of metallic copper. This is surrounded by a blue ring of the unaltered solution which is itself surrounded by a translucent ring containing bubbles of gas due to the action of the released sulphuric acid upon the gelatine.

Artificial cells are affected in structure and development by moisture, dryness, acids, alkalies, and various other substances added either to the drop of liquid or the surrounding gelatine. In this way many varieties can be produced, including cells with dark or light nuclei, with or without nucleoli, and cells of homogeneous protoplasm without nuclei, like the cells of blue algæ. The protoplasm may be separated from the cell wall and contracted about the nucleus, or it may fill the whole cell. The cells may be naked or surrounded by thick walls. They may be in contact with each other or separated by intercellular spaces, etc. If drops of water tinted with India ink are scattered over a solution of potassium nitrate, the cells, at first radially striped, soon become granular. Then segmentation takes place and the cells break up into polyhedral daughter cells.

The phenomenon of karyokinesis observed in the segmentation of living cells, with the characteristic spindle-shaped figure of curves connecting two focal points, is produced artificially by placing in a viscous fluid a tinted drop of the same fluid between two drops of greater osmotic pressure. The central drop represents the nucleus, the others the centrosomes of the living cell undergoing segmentation. The central drop becomes granular and develops a pigmented ring which represents the chromatic band of the natural process and, like it, breaks up into chromosomes. These move toward the centrosomes and collect about them, forming two nucleated pigmented masses. Meanwhile a partition has formed between these masses which is continuous with their spherical walls, so that finally we have the image of two cells, with nuclei, protoplasm, and cell walls, pressed closely together.

Prof. Leduc also produced in these experiments with drops phenomena of growth similar, on a small scale, to those obtained later with solid "seeds." When a solution of cane sugar containing a trace of potassium ferrocyanide is dropped into a dilute solution of copper sulphate the drop of syrup becomes covered with a pellicle of copper ferrocyanide, forming an artificial cell. Under the influence of the difference of osmotic pressure between the drop and the surrounding liquid, water passes inward through the membrane of copper ferrocyanide which the sugar cannot traverse. The drop, or cell, increases in size and puts forth a bud which is immediately surrounded by a pellicle and proliferates in turn. In this way is formed, slowly, a chain of connected cells, the last of which may have ten times the diameter of the original drop. This scientist, as above mentioned, had succeeded in proving the life of cells to be controlled by the forces of diffusion, the artificial cells and cell tissues obtained by him showing exactly the same behavior as that shown by animal and vegetable cells. The phenomena in question are best represented by considering the seat of the tendency to diffusion as a field of force, in every way resembling Faraday's magnetic and electric fields. In fact, any point in a liquid at which the concentration is greater than in the surrounding parts, represents a center of force of diffusion, and the same remark applies to points of lower concentration than their surroundings. If a point of the former kind be called a "positive pole of diffusion," a point of smaller concentration should be termed a "negative" pole. Now, poles of different kinds (Fig. 5) will attract each other in exactly the same manner as electric or magnetic poles of opposite signs, the general phenomena of motion being precisely the same in the two cases.

Mutual reactions of unlike poles, then, would account for the whole of the physiological phenomena of the organism. In fact they produce liquid currents which carry along any suspended particles, while the mutual reactions of like poles cause suspended particles to be accumulated in the neighborhood of a positive pole, thus producing the phenomenon of agglutination. Even in the production of cell tissues, as shown by the artificial tissue represented in Fig. 6, no other forces are present. By introducing a 5 to 10 per cent solution of potassium ferrocyanide into 5 to 10 per cent solutions of gelatine, the cell tissue represented in this figure is easily obtained; each such cell, like a natural one, possesses an enveloping membrane, protoplasm and a nucleus. With solutions of sodium chloride, however, entirely liquid cell tissues (Fig. 7) are obtained. All the varieties of cells observed in nature can thus be artificially produced by suitably regulating the conditions of the experiment. Even the strange karyokinetic figures produced during the segmentation of cells, and of which no adequate explanation has yet been given, are readily obtained in these artificial growths.

All living organisms are made up of solutions of crystalline substances and colloids; when their concentration increases, the molecular force of crystallization is manifested. Each center of crystallization surrounds itself with a field of force (Fig. 8) that in some cases is rather intricate, and whenever, besides the

Fig. 1.—An artificial plant which was produced in a test-tube.

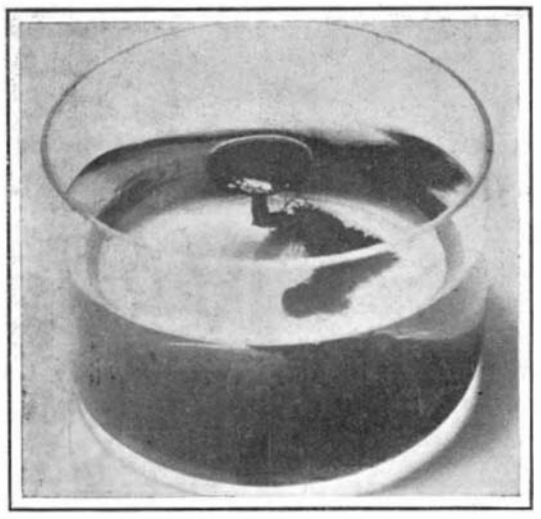


Fig. 3.—Culture of a single artificial grain.

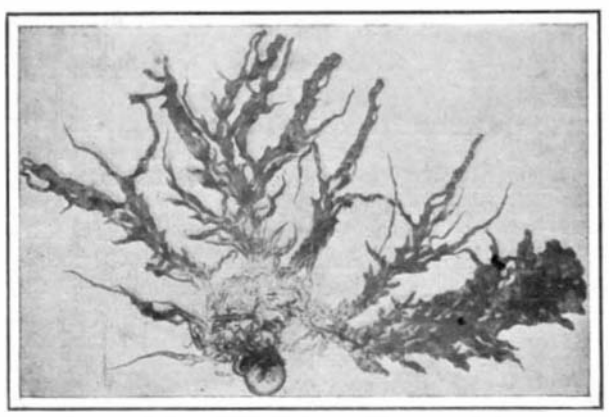


Fig. 4.—Artificial seaweed produced from an artificial cell.

Fig. 2.—Artificial organs showing mushroomshape.

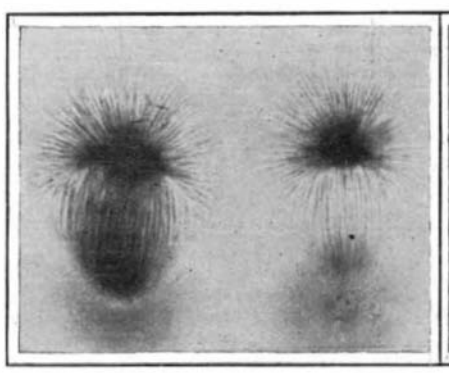


Fig. 5.—Field of diffusion between two opposite poles.

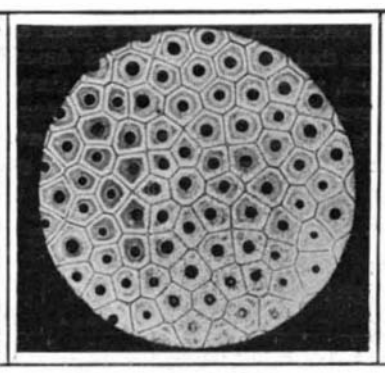


Fig. 6.—Artificial cell tissue.

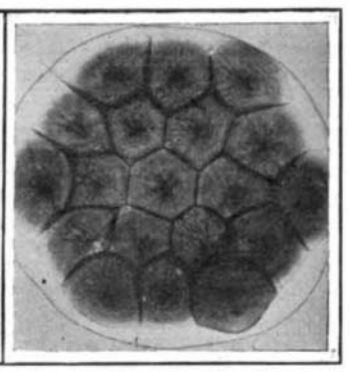


Fig. 7.—Liquid cell tissues.

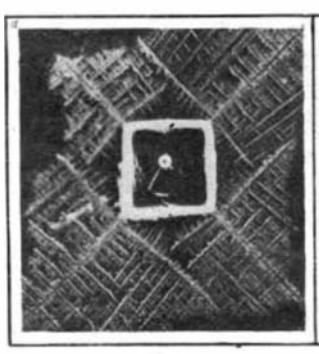


Fig. 8.—Sodium chloride crystal in its field of crystallization.

Fig. 9.—Morphogenetic effect of crystallization.

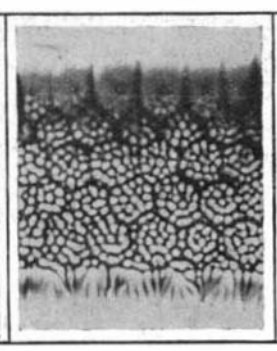


Fig. 10.—Segmentation of liquid artificial cells.

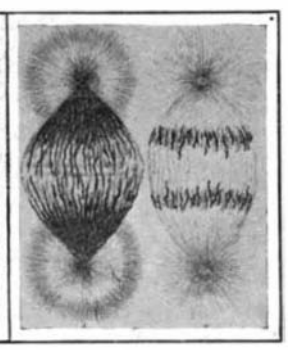


Fig. 11.—Artificial and natural karyokinesis.

LEDUC'S CURIOUS ARTIFICIAL PLANTS, CELLS, AND TISSUES, PRODUCED BY CANE SUGAR, COPPER SULPHATE AND POTASSIUM FERROCYANIDE.

Although they are composed of inert matter, these objects sprout, branch, and nourish themselves like actual living organisms.

* SCIENTIFIC AMERICAN, September 2, 1905.

forces of crystallization, other forces, differences in osmotic (diffusion) pressure, are present, forms are obtained which in their outward appearance resemble certain inferior organisms. As the solid tissues of organisms are produced by solidification from the solutions above referred to, their shape and structure necessarily are influenced by the force of crystallization (Fig. 9).

When drops of a solution are introduced into the same solution at different concentration, these drops at first spread out in all directions; owing, however, to the effect of molecular attraction (or cohesion) there soon takes place a granular segmentation of the liquid (Fig. 10). In fact, as this cohesion between the various molecules is different, those between which the attraction is greatest will combine into spherical grains as soon as the force of attraction exceeds the force of diffusion, while the other molecules fill the intervals between the grains. In this way the phenomena of segmentation observed in germinating eggs, which had previously seemed so puzzling, are not only accounted for but can be readily imitated by an artificial process.

From Lehmann's researches on apparently living crystals it is inferred that certain crystallized structures show a behavior quite analogous to inferior organisms, moving, growing, feeding, and propagating themselves like the latter. The investigations by Prof. Leduc which have been described above, on the other hand, prove that the fundamental element of animal and vegetable organisms, viz., the cell, is exclusively controlled in its vital functions by the same physical laws that govern the forms of the mineral kingdom. From both sides there is thus being constructed a bridge between the province of inert matter and that of living matter, and in the place of the strict barriers previously supposed, we are warranted in presuming the existence of a multitude of gradual transitions and intermediary stages.

It should be observed that the Leduc phenomena were first observed by Traube in 1867 (Archiv. f. Anatomie u. wissenschaftliche Medizin, 1867, p. 67), who produced them. Such artificial cells have long been known as Traube cells. Traube also produced them by means of tannin and lead acetate, water glass and lead acetate, gelatine and tannin, and the like. In repeating Leduc's experiments Prof. Hans Molisch found that the acetate and the chloride of copper produce better results than the sulphate. The sugar, salt, and gelatine serve to increase the growth and ramification, but it should be pointed out that Reinke described branched and tree-like artificial growths more than twenty years ago.* If crystals of copper sulphate are thrown into a solution of water glass they become enveloped in light blue pellicles of copper silicate and these silicate cells develop into tree-like forms if sufficient water glass is present.

Even Leduc's discovery that artificial cells, like natural cells, are affected by various influences was anticipated by Traube, who described the effects of light and gravitation and the variations in form and rapidity of growth produced by adding grape sugar, salt, etc. In Molisch's opinion Leduc's experiments mark no advance beyond the results obtained by Traube in 1867. His artificial cells teach nothing new and they are no more like living organisms than a paper flower is like a real flower or a wax doll is like a living child.

Prof. Gaston Bonnier, of the Académie des Sciences and the University of Paris, entertains very skeptical views of the biological value of Leduc's experiments. These views he has voiced as follows in La Science au XXme Siècle:

"I pointed out to the Academy, in the meeting of December 24, 1906, that these tubular precipitates had long been known and possessed no organization comparable with that of living things. I also repeated before the Academy, some interesting variations of these amusing experiments devised by one of my pupils—a minor. In La Revue of January, 1907, I showed that this alleged discovery was only a repetition of Traube's classical experiments.

"At the meeting of January 7, 1907, Prof. Leduc made a rejoinder to which I replied on January 14, as follows:

"In a lecture just published M. Leduc expresses his amazement that Pasteur's researches have for thirty years silenced the discussion of spontaneous generation, and the *brochure* ends with the words: 'To complete the synthesis of life only one function remains to be realized—successive reproduction. I regard this problem as of the same order with the preceding.' In his communication of last week M. Leduc asserts that his note of July 24, 1905, began with a mention of Traube's work. Here is the mention: 'We have an artificial cell similar to Traube's but differing from it in possessing the power, not only of expansion and enlargement, but also of emitting prolongations analogous to roots and stems, which grow visibly and slowly.' This sentence demonstrates Leduc's ignorance of Traube's writings,* from which I quote as follows:

"'Forms which sometimes resemble a rhizoma with long stemlike upward and rootlike downward extensions.'

"'Soon afterward the cell begins to grow exclusively at the top, so that it passes from a rounded to an elongated form. If the vessel is tipped the extremity continues to grow vertically.'

"'When the pellicle is ruptured the escaping solution soon becomes inclosed in a membrane of precipitate resembling a graft, excrescence, or branch of the cell.'

"Traube's forty-eight series of experiments made in 1865-7, and his later researches, published in 1875, include Leduc's results and many others. And these experiments have been varied almost *ad infinitum* by others. I need mention only Pfeffer's arborescent forms.†

"The conclusion to be drawn from all these experiments is that the form obtained depends on the medium and, to some degree, on the shape of the vessel.

"I have also obtained the Leduc forms by following Traube's general directions. The various salts were thrown into a 5 per cent solution of potassium ferrocyanide or a 10 per cent solution of sodium or potassium silicate. The production of these precipitates is a common lecture experiment. Leduc asserts that all forms obtained by earlier experiments were stunted, unstable, and shapeless but that his culture liquids produce large, stable growths with sharply differentiated roots, stems, and apical organs. But the descriptions cited above show that all of Leduc's results were obtained before him.

"Our colleague, M. Gerner, has produced growths which could be preserved in paper like dried plants and which were mistaken for seaweeds by amateur botanists. Some of these arborescent forms have long been exhibited in apothecaries' windows, especially at Nancy.

"It is difficult to see what new fact is brought out by Leduc's experiments. I am not now speaking of the curious experiments in which he reproduced the structure of organized tissues—that is a different question.

"In his notes to the Academy, Leduc asserts that his pretended artificial plants give evidence of cellular structure, circulating system, thermotropism, osmotropism, and nutrition.

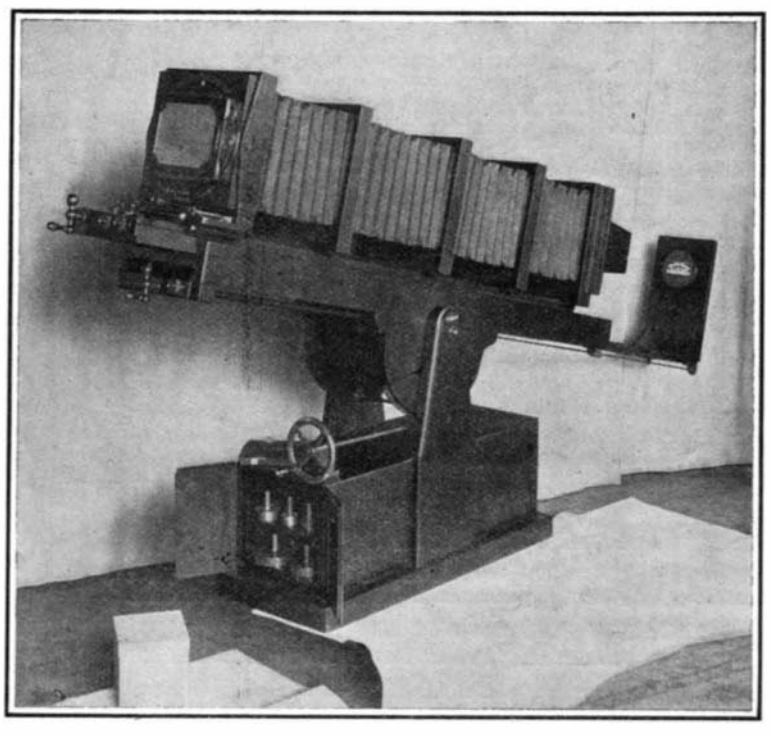
"It is well known that the forces which act in living beings are simply physico-chemical forces. Traube and others have studied the effect of these forces on semi-permeable membranes and Leduc has added nothing to their results. As for cellular structure and circulatory system nothing of the sort is to be found in these tubular precipitates.*

"It has been maintained that Leduc has made no claim to the creation of life by spontaneous generation, but this assertion is contradicted by his own words, quoted above.

"The net result of the whole affair is simply *nil*."

AN EXPERIMENT IN ACOUSTICS.

As the running boys pass the bell there is a distinct drop in pitch



SPECIAL CAMERA FOR COPYING AND ENLARGING.

AN EXPERIMENT IN ACOUSTICS.

BY GUSTAVE MICHAUD.

The school bell and good legs are all that are needed for this experiment. Students who make it find it easier, as a rule, to understand the relation between pitch, wave length, and the number of vibrations. Where elementary astronomy is taught, the same experiment may prove to be a helpful as well as a healthful diversion during the study of a rather abstruse chapter—the application of the spectroscope to the determination of the radial motion of stars.

Select the swiftest runner of the school. Give him a bell, and place him on level ground at some hundred feet from the rest of the class. At a signal, the students run as fast as they can toward the bell bearer, while he himself runs toward the students, without ceasing for a moment to ring his bell. So long as some distance remains between the students and the bell, nothing abnormal seems to occur, although the students, without being aware of it, perceive a sound of a somewhat higher pitch than that which strikes the ear of the bell bearer. But at the precise moment when the runners pass the bell, and instead of running toward it begin to run away from it, there is an instantaneous and very distinct dropping of the pitch of the sound, which remains graver as long as the distance increases between the runners and the man who rings the bell.

While the hearers are running toward the source of vibrations, they meet, in a given time, a greater number of these than if both the bell and the boys had remained in the same place. When the bell bearer and the students ran away from each other, the hearers go in the same direction as the vibrations, and the reverse phenomenon occurs—the number of vibrations which reach the ear in every second is smaller than it would have been had all the participants remained on the spot. As the pitch of a sound depends upon the number of its vibrations per second, that of the bell will drop at the very moment when the distance between bell and hearers ceases to decrease and begins to increase.

If the man who rings the bell can be provided with a bicycle, the fall in the pitch of the sound is of course still more pronounced.

SPECIAL CAMERA FOR COPYING AND ENLARGING.

The camera illustrated here is one that was designed and built for the United States Geological Survey for photographing fossils or other similar objects. In photographing fossils the Survey uses a process known as the Williams process. This method was worked out by Prof. Henry S. Williams and Norman W. Carkhuff, and consists in an elimination of the color of the fossil by a process of sublimation.

Fossils cannot be photographed for scientific purposes in a haphazard manner. There are certain characteristics that must always be orientated in relatively

* Reinke, Botanische Zeitung, 1875, p. 432.

* Moritz Traube, Centralblatt für medizinische Wissenschaft, 1865. Archiv. für Anat., Phys. und wissenschaftliche Medizin, 1867, p. 87. Botanische Zeitung, 1875, p. 56.

† Pfeffer, Osmotische Untersuchungen, 1877, p. 11. Botanisches Institut, Tübingen, 1886, vol. ii., p. 30.

* Prof. D'Arsonval, who presented Leduc's note, has recently (January 21, 1907) presented a communication from Charrin and Goupil describing experiments which prove that no phenomenon analogous to nutrition occurs in the production of these arborescent growths.

the same position and illuminated in the same way, in order to produce results of any practical value to the scientist. Some of these fossils are photographed to the same size as the original, while others are much enlarged; great accuracy is required in this particular. As some of these fossils are exceedingly small and delicate, it is obvious that to do the work economically special apparatus is required. Could a comparison be made between the first piece of apparatus used by the original experimenters and the apparatus just completed, the remarkable evolution in scientific camera building would make old camera operators wonder at the change.

The camera is mounted on a tilting base, so arranged that either end may be elevated or lowered to any desired position, in order to secure the proper lighting of the subject. The operator can make any of the following adjustments on the camera or subject without leaving his natural position at the back while observing the focusing screen: either move the subject back or forth from the lens or revolve the subject support; move the camera back or forth on the tilting stand; raise, or lower, or shift the front of the camera in either direction; revolve the back from a horizontal to a vertical position, or to any intermediate point; elevate or lower the subject support, in order to secure the proper lighting, all by mechanical devices. It will be observed that the rod running along under the base operates a mechanism below at the front for rotating the subject base.

The base of the stand contains two cabinets for storing lenses or small parts. The focal capacity of the camera, including cone extension, is 7½ feet; length of stand top, with subject support and camera extended, 11 feet; size of plate, 6½ x 8½, with kits to 3¼ x 4¼. We are informed that the apparatus was specially made for the purpose mentioned above by the Folmer & Schwing Company, of Rochester, N. Y. The design reflects much credit as an excellent example of American workmanship.

The Deadly Electric Wire and the Conditions Under Which It Is More or Less Dangerous.

The danger incurred in touching an electric circuit does not depend wholly on the voltage or electric tension. Two-thousand-volt circuits have been touched with impunity, and contact with incandescent-light circuits of only one hundred and twenty volts has caused instant death.

The physiological effects of electricity are due partly to electrolysis or decomposition of the blood and other fluids and partly to paralysis of vital organs. Both actions are proportional to the strength of the current that actually passes through the body and this current strength is equal to the voltage of the circuit touched divided by the electric resistance of the body. The average resistance measured between a hand and the feet, when the hand is moist and the shoes are soaked with water, is about 5,000 ohms. A current of one-twentieth of an ampere—one-tenth of the current used in an incandescent lamp—may cause death. Hence, the question is, Under what conditions will contact with an electric wire send such a current through the body?

If the right hand touches one wire and the left hand simultaneously touches the other wire of a 110-volt incandescent lighting circuit, the body, assuming its resistance to be 5,000 ohms, will be traversed by a current of 110/5,000 ampere, or little more than one-fiftieth of an ampere, which is within the limit of safety. But if the hands are dry the resistance measured from hand to hand is fully 10,000 ohms, so that both wires of even a 220-volt circuit, such as is used in some incandescent lighting systems, can be touched without danger of serious injury. In certain factories, however, where the air is damp, warm, and laden with acid vapors, the skin becomes softened and the resistance so greatly diminished that it is not safe to touch both wires of even a 100-volt circuit.

The writer's left hand once came so near the terminals of a 1,000-volt transformer that it drew luminous electric arcs from them. The current, having so small a resistance—less than two inches of the hand—to overcome, was very strong, but it caused no injury except local burns because it did not traverse a vital part. In instructive contrast to this case is the experience of the inventor of an electric bath tub containing metal plates that could be connected with a 220-volt lighting circuit. The inventor tested the device on himself and was instantly killed because soaking in water had so reduced the resistance of his body that even this low voltage produced a deadly current.

If a man, standing on a trolley rail or even on the ground, touches a broken trolley wire carrying the usual pressure of about 500 volts, a current of one-tenth of an ampere will pass through his body, if its resistance is 5,000 ohms, and will probably cause death. In this case the ground or the rail represents the second or return wire. It is much less dangerous to touch a single wire of a double-wire circuit, well insulated from the ground, for in order to reach the other wire the current that traverses the body must flow through or over some of the insulators, that is to say, through a very great resistance, so that the current is very weak. But in a very long line the sum of these little leakage currents through many insulators may be too great for a human body to carry with safety. Hence, the danger is proportional to the length of the line. Simultaneous contact with *both* wires of a high-voltage circuit is, of course, fatal.

The static electric charge of the wire, as distinguished from the flowing current, is another source of danger, at least in alternating circuits. In continuous-current circuits this charge acts only once, at the first instant of contact, but in alternating-current circuits the charge is changed from positive to negative and back to positive usually about one hundred times a second, and when a man touches the wire the electricity which forms these charges surges back and forth through his body. Most of the casualties produced by touching alternating circuits are due to this cause. The danger is proportional to the electric "capacity," and therefore to the length of the wire. Burying the wires increases their capacity and makes them still more dangerous to handle, but it effectually keeps the average citizen away from them.

The danger is proportional to the frequency of alternation, if the frequency is not very great, but currents of several hundred thousand alternations per second, such as Tesla employed in his amazing experiments, do not penetrate deeply, so that when they traverse the human body their effects are confined to the skin and are not serious. The facts that high voltages and high frequencies have been commonly associated in experiments and that extremely high frequencies have been shown to be harmless have led to the widespread belief that exceedingly high *voltages* are quite free from danger. This is entirely erroneous, as the curious reader may easily prove to his own satisfaction—or, at least, that of his heirs.—Condensed from Herman Zipp in Die Umschau.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

CORSET.—E. SAVOYE, Rue du Caire, Paris, France. The corset is so cut out as to enable the whole of the front and the whole of the upper part of the corset to be made up of a single piece, the continuity of which affords great advantages both in the way of comfort and facility of manufacture. This mode also obtains a continuous ornamentation, by means of embroidery, designs in colors, and the like, without any of the difficulties resulting heretofore from the construction of the parts in several pieces stitched together.

Electrical Devices.

TELEPHONE-MAGNET. — A. E. HARRISON, New York, N. Y., and C. M. HASLETT, Jersey City, N. J. The objects of the invention are, to confine the effect of a plurality of magnetic poles upon one or more pole-pieces; to give the pole-pieces such conformity as will enable the windings to be placed directly upon them rather than upon the magnets proper; to shape the pole-pieces so as to accommodate a large number of turns of the wire and also to decrease the loss of effective magnetic lines; to increase efficiency of magnets, and to provide a more direct path for the magnetic lines of force and also to concentrate their effect within a small area.

WIRING-KNOB.—W. C. GORDON, Windsor, Vt. The principal objects of the inventor are to provide for more securely holding wires than has been the case with prior inventions, and especially for so constructing the cap with which these insulators are usually provided that it will grip the wire equally at all times independently of the position in which it may be placed on the base of the knob so long as it is centered with respect thereto.

Of Interest to Farmers.

REELING DEVICE.—C. A. HADLAND, Bennington, Minn. This device is designed to be mounted upon a wagon-body so that the wire may be reeled or unreeled as the wagon moves; and the purpose of the invention is to improve upon the construction of the device for which Letters Patent were formerly granted to Mr. Hadland, the improvement being such as to simplify the construction and to render the action more positive and reliable.

HAY-STACKER. — B. F. POWELL, Manzanola, Col. One purpose of the invention is to provide a portable hay-stacking device in which a sled or hay-frame previously loaded upon the field is drawn up an incline and received upon a tipple of simple, light, and durable construction and wherein when the load is automatically dumped from the sled by means of the tipple the empty sled will slide down the incline in the ground of its own accord.

WAGON.—J. RUPPERT, Glencoe, Minn. This type of farm-wagon is capable of being quickly converted into shape for use as an ordinary box farm-wagon, a hay-rack, a stock-rack, or a wood wagon. The body is so constructed that it need not be changed under any condition of adjustment of the necessary added parts and so that such parts can be expeditiously and readily locked in position or removed, as required.

BALING-PRESS.—C. E. FIELD, Slater, Mo. One purpose of the improvement is to provide a construction of press in which a plunger is not employed and wherein the feed mechanism is such that the press can be fed at any time while in operation, it not being necessary to await the return of the plunger, as required in presses known to the inventor.

STALK-CUTTER. — F. P. CHAPA, Alice, Texas. In this patent the invention relates to devices for cutting cotton, corn, or other similar stalks, and has for its object to provide a device adapted to be drawn along between two rows of standing stalks and cut them by novel and improved means. The device in use is drawn by manual, horse, or other power.

Of General Interest.

DRY-GOODS MARKER.—P. H. STEWART and E. A. MILLER, Hopkins, Mo. The marker is designed to be applied to the center board of a bolt of cloth at one end thereof and automatically engage the same, holding it in fixed position. A card of celluloid or like material is held to the front face of the marker by inturned retaining-cleats, the latter having nibs extending at each end, which are bent in such a manner as to prevent the celluloid card from sliding from the cleats.

NON-REFILLABLE BOTTLE.—H. N. ROTHWEILER, Seattle, Wash. The bottle is designed for containing spirituous liquors, proprietary preparations, table condiments—such as catsup, sauces, etc.—and any other materials in liquid form in which the refilling of the bottles with a surreptitious substance is to be prevented. The invention consists in the construction and arrangement of the bottle in combination with a valve, a sealing cap, and dispensing devices designed to be filled and also discharged under an air-pressure.

ROLLER-SUPPORT FOR EDGEWISE-MOVABLE DOORS.—G. GEORGENSON and J. E. HENNEN, Fond du Lac, Wis. The invention is characterized particularly by an operating-handle convenient as a handle for pulling the door open or closed and also for shifting the rollers on which the door slides, so that when the handle is in idle position the shoes at the lower edge of the car-door rest upon the track on which the door slides, so that it will not accidentally slide open; but when the handle is operated the rollers are pressed down upon the track to lift the door and shift the weight onto the rollers, so that the door will readily move.

FLOWER-BAND MOLD.—A. M. LOCKARD, Herrin, Ill. This molding apparatus is for producing a flower-band from molded or cementitious material. The flower-band referred to is a device made in circular form and either in one piece or in sections for use in surrounding and protecting flowers, shrubbery, or young trees.

AUTOMATIC GRAPPLING-HOOK. — B. LANGLEY, Woodward, Oklahoma Ter. The object of the inventor is to provide a device which will grapple and automatically take hold of objects with which it comes into contact. It may also be used as a means for returning lost tools, buckets, casings, etc., from wells and cisterns, and for use in removing safes and other valuables from burning ruins and other places inaccessible by usual methods. It may be used for removing stumps, logs, and all heavy foreign matter from lakes, etc.

BUFFER.—S. M. GOLDBERG, New York, N. Y. The principal object of this invention is to provide a toilet article with a buffing-surface which can be readily removed and replaced, so that when worn the entire article does not have to be discarded, also to provide means for securely holding the buffing material upon a base, and to provide a removable handle.

BOBBIN.—G. POPPLEWELL, Louisville, Ky. The invention refers to bobbins, more particularly such as are used on drawing, spinning, and twisting frames. The object is to provide a bobbin which is simple in construction, exceeding strong to stand all ordinary wear and allow repeated use of the bobbin. While extremely hard the bobbin is slightly flexible and well adapted to withstand rough usage.

DEVICE FOR EXHIBITING HATS, BONNETS, AND THE LIKE.—F. W. NUNN, Guilford, New South Wales, Australia. The object of the inventor is to furnish a device on which the article to be displayed can be quickly and firmly fastened and also readily removed, while it can be quickly changed from an upright to an inverted position or placed at any angle in order to show the article to its best advantage, according to its position in a show-room or shop-window.

FASTENING DEVICE FOR ORNAMENTS.—J. L. PAUL, Chicago, Ill. A purpose of the improvement is to provide a fastening device for ornaments adapted for application at the seam in any piece of metal work or cabinet work to cover the seam, being particularly for use on picture-frames, the application being made without danger of marring the ornament or the article to which it is applied.

AIR-SHIP.—J. A. ELSTON, Jefferson City, Mo. The purpose in this case is to provide an air-ship or vessel very light and strong, and wherein the operator will be comfortably seated and able to manually operate it with ease and slight bodily exertion. Another purpose is to provide a construction in which wings are employed as a motive power, with or without assistance of balloon or gas-bag or its equivalent, and wherein the operator will be protected from the elements.

LIQUID MEASURING AND REGISTERING FAUCET.—W. M. DAVISON, Government Road, Port Pirie, South Australia, Australia. The device consists, essentially, of a measuring plug or chamber fitted within a body or case, at one end of which is a registered mechanism operated by the movement of the measuring plug. The body has on one side a tubular inlet projection, whereby it is fitted to the neck of the bottle, the barrel, or other liquid-containing vessel and has on the other side an outlet-spout, from which the liquid is delivered into the glass or other receptacle.

POINTING-TOOL.—B. F. DAVIS, Miami, Fla. The aim of this improvement is to provide a tool especially adapted for pointing up masonry and other structures where liquid or semi-liquid mortar or cement is to be applied at the finishing operation and to so construct the device that it will be simple and economic and capable of operation by one hand.

CRYPTOGRAPH.—H. BURG, Mollkirch, Canton de Rosheim, Alsace-Lorraine, Germany. In this apparatus each change of combination is produced by the displacement of a carriage which is reciprocated directly by hand, the extent of such reciprocation varying automatically each time, according to a predetermined law, and this reciprocation of the carriage is transmitted to a crown of letters movable concentrically with respect to a fixed crown of letters, the said crowns serving to make the cryptographic translations.

PROCESS OF FORMING OIL-CUPS.—J. TOWERS, Albuquerque, Ter. New Mex. Generally stated, the process consists in taking a round bar of iron or steel, upsetting the end in a die of suitable fashion to form the base and stem of the cup, and thereafter welding a pipe thereto and further shaping the upset portion in a second set of dies to form the complete cup.

Hardware.

MITER-BOX.—J. PEACH, Traverse City, Mich. In the present patent the invention has reference to wood-sawing, and its object is the provision of a new and improved miter-box arranged to permit of cutting the wood or other material at any desired angle and without changing the position of the saw in the saw-guides.

Heating and Lighting.

GRATE FOR BOILER-FURNACES, ETC.—P. S. SPILLER, Austin, Texas. In this instance the invention has reference to an improvement in grate-bars for steam-boiler furnaces, stoves, or any fire where soft coal, lignite, or any other fuel is used which throws off carbon, its object being to produce a higher degree of heat than is obtained by the usual grate-bars.

Household Utilities.

CABINET.—MARION W. RANDOLPH, Seattle, Wash. Mrs. Randolph's invention is intended especially for use by those who live in apartments of a few rooms where there are no housekeeping conveniences and for those cases where there would be objections to odors which commonly result from the use of gas, coal-oil, or alcohol, and the invention also seeks to avoid the objectionable odors experienced in cooking fish, cabbage, onions, or the like.

Machines and Mechanical Devices.

MEASURING AND REGISTERING PUMP.—W. M. DAVISON, Government Road, Port Pirie, South Australia, Australia. The invention comprises a device whereby publicans and others are enabled to accurately measure out quantities of liquids—such as pints, half-pints, and butchers—and at the same time a record is kept of the number of such measures sold. It is especially useful as a check upon bar attendants, the register being so constructed and operated that it cannot be tampered with.

PIANISSIMO DEVICE.—H. METZGER, Castleton, N. Y. When the soft pedal is pressed in ordinary pianos and the hammer-rest rail is swung rearwardly then the hammer-butt moves away from the upper end of the jack, and when the key is subsequently pressed and the jack raised, it moves a distance inactively before reengaging the hammer-butt and imparting movement to the hammer. To compensate or overcome this inaction or lost motion of the jack is the object of this invention.

CHARGING APPARATUS.—T. F. WITHERBEE and J. G. WITHERBEE, Port Henry, N. Y. The invention relates to a charging device especially designed for blast-furnaces, but capable of general use. By charging through the large or the small bell, as conditions may require, perfect control of the distribution of the charge is given to the furnace manager. If more than one kind of fuel be used, or if it is desired to charge some particular kind of ore at some special locality, it can be readily done by use of the invention.

Railways and Their Accessories.

SNOW-PLOW.—J. S. STOUT, Oxford Junction, Iowa. One of the purposes of this improvement is to provide a plow especially adapted for use upon railroads for removing snow and to construct the plow in multiple shovels arranged in a bank one above the other, each shovel being independent in its action, throwing the snow to the rear at each side of the structure.

BRAKE-SHOE ADJUSTER.—J. S. ASHWORTH, East St. Louis, Ill. The object of the inventor is to provide means adapted to automatically compensate for the wear on the brake-shoe and to keep the shoes normally in the same position relatively to the periphery of the wheel, so that the levers operating the brake-shoe will be kept in a state of constant efficiency and remain so until the brake-shoes wear out.

CAR-DOOR.—JOSEPH A. BOURGEOIS and JOHN A. BOURGEOIS, Algiers, La. The invention relates to car-doors; and the object of the invention is to produce a door which may be readily opened and closed and which may be substantially water-tight when in its closed position. On account of the manner in which the edges of the doorway are beveled it is impossible for rain to leak through the door when it is closed.

SAFETY-APPLIANCE RIVET-BOLT.—J. W. CURRAN, Newport, Ky. The object of the invention is to simplify the present methods of applying grab-irons, sill-steps, uncoupling-lever brackets, stake-pockets, air-pipe clamps, retaining-valves, brake-staff stands, etc., to steel freight-cars. The present method when one of the steps, clamps, or the like becomes broken necessitates the moving of the freight inside the car in order to get at the rivets for cutting out the same.

Pertaining to Vehicles.

AXLE.—H. K. BRYSON, Fayetteville, Tenn. A purpose of this invention is to provide a bearing for the hub of a wheel which will not only permit the wheel to turn with a minimum of friction, but which will also provide a cushioned support for the hub, enabling the wheel to have a vertical movement without lost motion, thus tending to render a vehicle to which said axle-spindle is applied easy riding, even upon very rough roads.

HARNESS.—D. A. LEE, Hot Springs, Ark. In the present patent the invention has reference to certain improvements in harnesses for horses whereby the weight of the collar on a horse's neck may be relieved and distributed to other portions of the body to prevent the neck from becoming sore through the chafing of the collar.

Designs.

DESIGN FOR A BOX.—W. JONES, Lurgan, Ireland. This ornamental design is intended for representation on the top or cover of a box. Three upright frames of simple structure are upheld by the hands of a boy and two girls. Each frame holds a domino poised on its end and showing the face or spot portion of the domino.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

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Minerals sent for examination should be distinctly marked or labeled.

(10423) D. C. C. says: Please settle the following dispute through your Notes and Queries column. Suppose two wires to be connected to opposite poles of a battery or other source of an electric current. A claims that as long as the wires are not connected they are not charged, i. e., that there is no current passing over the wires. B claims that the wires are charged continually as long as they are connected to a source of current, whether the wires themselves be connected or not, claiming that if they are not charged why is it that a person taking hold of them receives a shock? A. The two poles of a battery or other source of electromotive force are always charged, as you call it. The wires leading from a dynamo or battery anywhere along their length are at a difference of potential equal to the e.m.f. of the source of energy. And if a connection be made between them, a current will flow. The difference of potential is regarded as the cause of the flow of the current, and is expressed in volts, while the current is expressed in amperes. While the wires are not connected, no amperes are flowing, but the volts between the wires are just as great as possible. B is right in his opinion.

(10424) A. McK. says: A friend of mine got into an argument with me concerning the moon. He said that "every time the moon makes a revolution round the earth it makes one revolution on its *own axis*." I said that "as the same side of the moon was always toward the earth, I cannot understand how it can revolve on its *own axis*." Will you please say which of us is right? A. Because the moon keeps the same face toward the earth it must rotate once on its axis while it goes around the earth once in its orbit. To show this take a ball or an apple or anything round in the hand, and place a lamp on a table in the middle of the room. The ball is to represent the moon, and the lamp the earth. Now carry the ball around the lamp, keeping the same face of the ball always toward the lamp. You will have to rotate the ball as you carry it in such a way that it will turn entirely around on its own axis while it is carried once around the lamp. Try it again in another way. Mark one side of the ball. Begin on the east of the lamp, with the mark toward the lamp. The mark will be on the west side of the ball. Carry the ball around to the north of the lamp, with the mark always toward the west, that is, without rotating the ball on its axis. The mark will not now be directed toward the lamp, which is now south of the ball, and the mark must be turned from west to the south a quarter of a circumference before it is again toward the lamp. Repeat this at each quarter of the way around the lamp and you will have turned the ball through an entire circumference in making the circuit of the lamp and bringing the same face of the ball toward the lamp at each quarter of the circuit of the lamp. The moon does rotate once on its axis during each lunation. So also do Mercury and Venus in each of their revolutions around the sun, and they also keep the same face always toward the sun. Should the earth come into the same relation to the sun, a day will be a year long. Many astronomers think this will be the case at some time in the remote future.

(10425) D. LeM. C. asks: 1. I am contemplating making the large plunge battery described on page 400 of "Experimental Science," and would like to know of whom I can buy the zinc and carbon plates there described. A. You can get the zinc and carbon plates of any size you may wish by addressing dealers in electrical supplies. See our advertising columns. 2. Also, it says to use gutta percha for the lining of the cells. All that I have been able to find in this city is some very thin gutta percha (about like a sheet of paper), and was told that it was used in the repair and manufacture of clothing, something like glue. Is this what the book means? If not, where can I buy what it does mean? A. We think you would do much better to use glass jars for the cells of the plunge battery, but if you prefer hard rubber you can get them from the same company. They can send you a list of such jars as may be on the market. 3. On page 92 of "Experimental Science" it tells how to make an air pump from rubber tubes. Is such a pump durable? Will it crack and leak after being used a few times? I tried to buy the rubber, but was told that it would cost three of four dollars. Please tell me where I can get it for $1.50 as the book says. A. We cannot say that we think you would find an air pump made with rubber tubing of much real service. It might do for amateur work for a short time, but would not be durable. You cannot get much rubber tubing now for $1.50. Prices are much higher than when "Experimental Science" was written eighteen years ago. 4. In the description of the electromagnet on page 458 of "Experimental Science" it gives the width of the soft iron yoke as 2½ inches and the diameter of the wooden spools as 4 inches. According to these dimensions, the spools would be larger and project over the iron yoke. Yet in the engravings the yoke is the largest, and the spools do not project over it. Which is right? Will it decrease the power of the magnet if the walls of the spools are more than 1-16 inch thick? A. The drawing of the yoke of the electromagnet on page 458 does not correspond to the dimensions given in the text. That does not matter, since every one knows that the yoke needs to be at least of the same cross section as the core, and may be as much larger as may be convenient. If it is broad enough to serve as a base for the magnet to stand upon, no harm is done. The walls of the spools do not affect the magnetism. If they are made thicker than necessary, the windings will be so far from the core that the magnetism will be weaker and the magnet will not be strong for it. Make the spools as light as you can and still strong enough to hold the wire.

(10426) T. H. A. says: 1. Quite often I have to recharge small storage batteries of 6 volts. The only method I have to know when the battery is fully charged is by the solution throwing off quite a lot of gas bubbles. I have been told that I should have a hydrometer to do the storing correctly. What size hydrometer should I get for these 6-volt cells, and where can they be had, and about what is the price? The solution is made of one part of C. P. sulphuric acid to four parts of distilled water. What should the hydrometer read before the solution is charged and when fully charged? In drawing off the solution from the battery while charging to get a hydrometer reading, if the plate is exposed much will it injure the battery? I have been told not to charge a battery up to its full voltage. For example, take a 6-volt cell. I start charging at 5 volts until the cell starts gassing, then cut it down half (2.5 volts) until gassing gets heavy again. Is that proper? A. It is a common way to judge of the charge of a storage battery by the bubbles of gas which are given off from the plates. When the gas comes off freely, the cell is fully charged. The material of the plates is no longer able to take up the oxygen and it appears at the positive pole, as the hydrogen does at the negative pole. The best way of testing the charge is by means of a voltmeter. A battery is in need of charging when the voltmeter shows 1.7 volts per cell. It is fully charged when the voltmeter indicates 2.5 volts per cell, or perhaps a little more than this figure. The hydrometer test consists in floating a glass hydrometer in the liquid of the cell, and charging till the liquid has a density of 1.3 on the scale. When the cell is discharged, the hydrometer will probably indicate about 1.1. 2. A claims that in foggy weather, when the smoke descends to the ground, that the atmosphere is light and will not support the smoke. B claims that it is heavy and will not permit the smoke to ascend. Which is correct? A. When smoke falls toward the ground the air is light, so that the hot smoke is heavier than the air. In fine weather the air is heavier and the smoke rises.

(10427) G. L. H. says: Will some scientific reader kindly enlighten me upon the two following problems, which have been subjects of argument to some of us recently? 1. A body sinks and is swallowed up in a quicksand, the body being actually lighter in specific gravity. Why? A. Light quicksand is not much heavier than water, and the fine particles of sand nearly float in water as a sediment. The sinking of a person in quicksand we have always thought to be due largely to the struggles of that person; the sticky mass holding him as he tries to rise and giving way under him as he treads in it. If we were caught in quicksand we should throw ourselves flat and keep as quiet as possible, spreading ourselves out over as large a surface as possible. 2. How is it that salt (sea) has so bad an effect on a human being when absorbed into the system, producing madness, etc., as in the case of shipwrecked mariners? The human body, in its constituents, is almost the same as sea water. Does the drinking of sea water necessarily produce mania, or could a person under normal circumstances drink salt water without harmful results? A. A person cannot drink sea water without nausea. It also produces most intense thirst. It is, we suppose, from the thirst that the awful condition of men in an open boat at sea without fresh water comes. No person could drink water with ordinary salt in it for any length of time without harmful results; much less could any one drink sea water, which contains other and less agreeable mineral salts.

(10428) A. W. D. says: Will you please inform me if it is possible to electroplate material with aluminium the same as can be done with copper or silver? If such is the case, will you please tell me what SUPPLEMENT will give me an account of the process? A. There have been many processes of plating with aluminium described in papers and in patents. We have never tried any of them, so as to know by actual experience that they are reliable. Watt says of them in the last edition of his "Electro-plating," page 476: "The present writer has never seen any sample of aluminium so deposited, and has never heard of any well-authenticated case of it having been so obtained." His book contains the several methods hot and cold which have been employed for this purpose. We can send you the book for $4.50. Plating with aluminium is perhaps a possibility, but an improbability.

(10429) J. T. W. says: Can a person buy books that would be of as much value to him as a correspondence school course in the study of mechanical electrical engineering? If so, what books do you recommend, and at what price, and where can same be obtained? A. It is not likely that a person unaided can obtain as good a knowledge of electrical engineering by reading as by study with the assistance of a correspondence school. It should also be stated that no school can make a scholar. The scholar makes himself, even in the best school. The books of a correspondence school are usually up-to-date and practical. The assistance of the examination papers and the correction of mistakes are also worth something. Should you wish books we can supply them, the best to be had on the subjects: Sloane's "Handy Book," $3.50, a reference book of facts and principles. Thompson's "Dynamo Machinery," $7.50, Vol. 2, Direct and Alternating. Crocker's "Electric Lighting," $6, two volumes, the best book on the subject. Foster's "Electrical Engineer's Pocket Book," $5, indispensable. Kent's "Mechanical Engineer's Pocket Book," $5, indispensable. Bell's "Electrical Power Transmission," $4. After these come books on railways, telephones, and all the special branches of work which you may wish to follow.

(10430) J. R. says: 1. What is spontaneous combustion? A. Spontaneous combustion is the setting on fire of a material by heat which is generated in itself by the contact with the oxygen of the air. 2. What is the cause of same? A. The drying oils used in paints, linseed oil chiefly, dry by absorbing oxygen from the air. The combination of the oil and oxygen is a slow combustion. If this goes on in a confined space where the heat cannot easily be radiated, the temperature will rise high enough to ignite cotton rags. Such oily rags often are the causes of setting a building on fire. 3. What degree of heat causes it? A. The temperature necessary to set an article on fire varies with the material.

(10431) J. L. P. says: In your answer to question 10342, January 26, you state that two spheres of the same size will fall with the same velocity under the action of gravity in the air. If the specific gravity of one of the spheres was less than that of the atmosphere it would rise, and if just a little more it would fall very slowly. Therefore it must follow that the greater the specific gravity of a body the more rapidly it will overcome the friction of the air, and consequently will fall faster than a body of the same size and shape but of a less specific gravity. Would that not be the case? A. You misconstrue the answer to Query No. 10342 by overlooking the fact that the query was specifically about lead and aluminium spheres. These will fall as stated for a limited distance with equal velocities. The fault with the answer is that this distance is not stated, an omission for which we are not able to account. This distance is placed by Wood in his "Mechanics" at from 100 feet to 200 feet, a distance which we have not verified. Aluminium is 2,000 times as heavy as air, and lead is about 9,000 times as heavy as air. The power of aluminium to overcome the resistance of the air is only one-fourth as much as that of lead, but it is 2,000 times as much as that of the ball which you assume.

(10432) J. M. P. says: 1. I am constructing a Wimshurst machine with two plates. How far apart should the plates be? How many sectors should be on each plate? The plates are 16 inches in diameter. A. The plates of a Wimshurst machine should be run as near to each other as they can be made to do without touching. You may be able to bring them about a quarter of an inch apart. 2. Would a large test tube be all right to make a Leyden jar with? How can I coat the inside of the jars, and how high up should the tinfoil come? A. The Leyden jars should be about 2 inches in diameter and 6 inches high. Use rather stout glass free from lead. Cut the tinfoil into strips an inch wide for the inside, and after the paste is applied put them inside

the jar and with a paper cutter, and perhaps a brush, smooth them into their places. A little practice and handiness will enable you to make a good job of it.

(10433) E. E. L. says: Is there any difference in the energy of a boiling liquid in different latitudes, the atmospheric pressure being the same for each place? What is the intensity of an ordinary saturated steel magnet as compared with the earth's magnetism for any given locality? A. The boiling point of a liquid is independent of the latitude, and the energy of the steam is the same for all places where the temperature of boiling is the same. The temperature of boiling is the same for all places which have the same barometer reading, wherever they may be on the earth's surface. The magnetic intensity of a steel bar magnet is, according to the tables given in Thompson's "Electro-magnet," from 14,000 to 16,000 lines per square inch.

(10434) J. T. says: 1. What is the cause of the large ring which appears around the moon in threatening weather? A. The lunar and other halos are produced by the action of the drops of moisture or ice crystals in the air upon the light as it comes toward the eye. 2. Why does not the atmospheric pressure, 15 pounds to the square inch, crush the small incandescent electric lights, which are supposed to be exhausted of air, or any other glass vacuum? A. An incandescent lamp bulb is not crushed by the pressure of the air upon it because it is strong enough to hold up 15 pounds per square inch. An empty eggshell will hold a pressure of 675 pounds per square inch on its end. 3. Why does not the upward motion of a bird's wing completely neutralize the effect of the downward motion? A. The up stroke of a bird's wing is executed so as to take the air at a different angle from the down stroke. The feathers do not return upward so as to present the same resistance to the air as they did when they were struck downward. 4. Why is the power of a telescope or microscope limited? A. The magnifying power of a microscope is limited by the indistinctness of the image in the extreme powers. The telescope is limited by the faintness of the light at great dispersion, and more by atmospheric conditions.

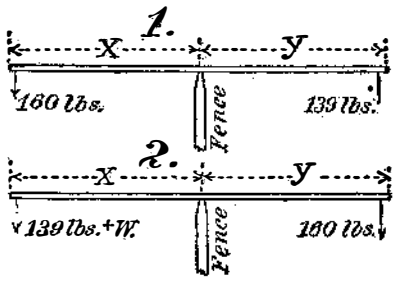
(10435) B. D. M. says: 1. Is it possible to generate light without heat? If so, give illustrations. A. It may be possible to generate light without heat, but it has not yet been done. It is one of the *ignes fatui* of inventors, like the utilization of tidal power and of the heat of the sun's rays. 2. Give proof that ice freezes at the underside, after a layer has formed, and not at the top. A. The proof that ice forms from the underside is that water is in contact with that surface of the ice and the upper surface is at the same time dry. The ice increases very rapidly in thickness to the extent of several inches on a severe night. The only other source of moisture is the vapor of the atmosphere, and that is not sufficient in quantity to supply the amount of ice which forms in a few hours. If the ice came from the air, the rapidity of its precipitation would exceed that of a heavy rainstorm.

(10436) J. L. B. says: On page 199 of the SCIENTIFIC AMERICAN of March 2, 1907, in the Notes and Queries department, No. 10409, you say a vessel sinking will always go to the bottom, because the water pressure will tend to make it heavier with reference to the water. Why will it be made heavier than the water? I can understand the water compressing it to a given extent, but not to such an extent as to make it heavier than the water. You also say that "at greater depths it will be able to sink faster, since the water is not compressed to any extent at greater depths than it is near the surface." Some years ago Dr. Dall, of the Smithsonian Institution, showed that the compression of water on the ocean bottom was about two tons to the square inch, and higher up about half a ton. Would a vessel be compressed to such an extent in sinking? It seems to me that this would mean that a vessel weighing two tons would need to be compressed *more* than enough to occupy a square inch at bottom to cause it to sink. Since you say it would reach the bottom, I am willing to take your word for it, but I can't understand it. Again, I read in a scientific periodical called The Lens (date of publication unfortunately forgotten) that although the ocean bottom had been sounded for several miles deep, bottom had never been found in Lake Tahoe, because (as explained) the water pressure prevented the weight used from sinking more than several miles, at which point the temperature of the water was considerably below freezing, but on account of the great density of the water it was unable to congeal. I fail to understand how water is able to compress an object to a greater extent than the water itself is compressed, and when both are compressed to the same extent, the object hangs suspended in the water without moving in either direction. The periodical above referred to reasons from this that the bodies of the people drowned in this lake (none of which have ever been recovered) are compressed to the size of a new baby, and are suspended, frozen stiff, about two miles below the surface. A. A vessel which is lighter than the water will not sink in water; a vessel in order that it may sink must be heavier than water at the start. All iron ships are heavier than water. So are wooden ships when ballasted. Such a vessel will sink if filled with water. If it sinks at all it will go to the bottom, since water is compressed but little by the pressure it sustains, and iron, wood, etc., are compressed more than water by the same pressure. Dr. Dall showed that the pressure at the bottom of the ocean was two tons to the square inch, not as you say, the compression of the water. Water is not compressed a very great deal by a pressure of two tons to the square inch, not so much as a stone would be. Water is compressed about 1-75 part by that pressure, that is 75 cubic inches would become 74 cubic inches, and not, as you say, to 1 cubic inch. With reference to what you quote from a paper about Lake Tahoe, we can say that it is impossible. Water cannot be cooled below freezing by any possibility and remain water in an open lake. And water must be colder on top if the temperature of any part of the water is at the freezing point. Dead bodies are not frozen in water down deep below the surface. Nor is water ever dense enough to prevent lead from sinking in it.

(10437) C. B. R. asks: Will you kindly explain who has the advantage in the following case, and why? In shooting at flying targets thrown from the traps, I shoot with both eyes open. My friend claims I should close one eye, as I could get a better alinement of the gun. My claim is that I can get a better and quicker sight at my target by using both eyes. Please explain what part the left eye plays while shooting right-handed. Do I shoot crossways, look crossways of the gun barrel, or do I unconsciously sight with one eye, while both are open? Give the theory of aiming a gun with both eyes open. A. If you can shoot with both eyes open and hit, it must be that you aim with the right eye and disregard the line of sight from the left eye to the target. You can test this by looking along the gun without shooting with both eyes open. You can determine whether the sights are in line with the right or with the left eye. We do not know any theory of aiming with both eyes open. Most people use but one eye at a time when both eyes are open. Some habitually use the right and others the left eye at their ordinary work.

(10438) J. O. B. says: I find that upon holding an electric light incandescent lamp by the glass and applying the metal to an idler on the main belt of the dynamo (which gives about 15-inch spark) and taking it away, I can get a powerful charge by placing my other hand on the metal. Can you explain? I also find the lamp "burned out," but it still gives the above results. A. By holding the incandescent lamp as you describe you charge it as a Leyden jar is charged, and upon touching the metal which is connected to the inside of the jar you receive the shock of the discharge. The metal and the filament are the inside coating, and your hand holding the bulb is the outside coating. The charge is a charge of static electricity.

(10439) P. A. O. says: Will you be kind enough to give the answer to the following problem, which has agitated the best mathematicians of our town recently: A farmer and his wife desired to weigh a pig, and had no scales. The man weighed 160 pounds and his wife 139 pounds. They put a board across a fence so that when they sat upon each end of the board it exactly balanced. Then they changed places, the wife taking the pig in her lap, just balancing the board again. How much did the pig weigh? A. Your problem may be solved in the following manner: Referring to



accompanying sketch No. 1: x = distance from the first position of the man to the fence. y = distance from the first position of the wife to the fence. Let w equal weight of the pig. Then $160x = 139y$. 160 pounds = weight of the man. 139 pounds = weight of his wife. In sketch No. 2 the man and his wife exchange places, and the wife takes the pig in her lap, and they again balance as in the first position.

Therefore:

$$(139 + w)x = 160y.$$

Also from sketch No. 1:

$$160x = 139y$$

$$\therefore x = \frac{160y}{139 + w}$$

$$x = \frac{139y}{160}$$

$$\therefore \frac{160y}{139 + w} = \frac{139y}{160}$$

$$160^2 = 139(139 + w). \quad w = 45 + \text{pounds.}$$

Therefore the pig weighs approximately 45 pounds.

NEW BOOKS, ETC.

ARTILLERY AND EXPLOSIVES. By Sir Andrew Nobel, Bart., K.C.B. New York: E. P. Dutton & Co., 1906. Large 8vo.; pp. 548. Price, $6.

The fact that this work consists of a series of essays and lectures written and delivered at various times by the author, detracts nothing from its value. Indeed, had it been planned and written as a co-ordinated whole, instead of being a compilation of separate essays, etc., it must still have been recommended for what it is, namely, a reference work to which the student of artillery and explosives will turn for information on subjects upon which correct information is only too scarce. The great value of this work will be at once evident, when it is stated that it consists largely of a record of the experimental work done by the author throughout the long period covered by his industrious professional life of nearly half a century. When Sir Andrew Nobel entered the service, the line-of-battle ships in the British navy were all sailing vessels, and their armaments and appliances differed but little, except as regards size, from those used in the days of Henry VIII. and Queen Elizabeth. The spirit of conservatism pervaded both services, and the introduction of rifled ordnance was received with the greatest distrust. It is impossible to speak in any detail of a work of this magnitude; but the chapters on the Tension of Fired Gunpowders, on Friction in the Bores of Rifled Guns, and those dealing with the Tension of Gases Expanded Without Doing Work, will be read with the deepest interest at the present time, when the subject of erosion of guns is so much in the public mind. There is probably no one who has had wider experimental knowledge of the subject treated in this volume than its celebrated author. When he first took up the examination of gunpowder, knowledge on the subject has been described as "simply chaotic"; and the description of the investigation made by Sir Andrew Nobel and his associates of the action of powders when fired in completely inclosed vessels, makes extremely interesting and profitable reading.

POOR'S MANUAL OF THE RAILROADS OF THE UNITED STATES. Street Railway and Traction Companies, Industrial and Other Corporations, and Statements of the Debts of the United States, the Several States, Municipalities, etc. New York: Poor's Railroad Manual Company, 1906. Large 8vo.; pp. 1808. Price, $10.

With its 1,808 pages and its well-earned reputation for accuracy and voluminous information, this number continues to hold for the Manual the high place which it won among railroad men and the public generally many years ago. The following important features, heretofore published separately in the Railroad Manual Appendix, have been incorporated; namely, first, all data embraced in Poor's Ready Reference Bond List; second, Table of Annual Meetings, Transfer Agencies, etc.; third, Table of Dividends paid for eight years. By the addition of the new features referred to, and the natural expansion of the regular departments of the book, the work this year has increased in text 192 pages, the statements for no less than 120 industrial corporations having been procured and incorporated in this new issue. Attention is also directed to the improvement in the index pages and to the great increase in the number of railroad and other maps.

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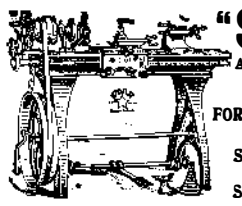

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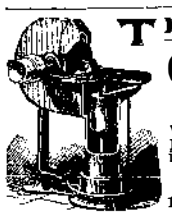

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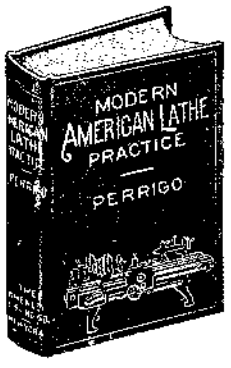

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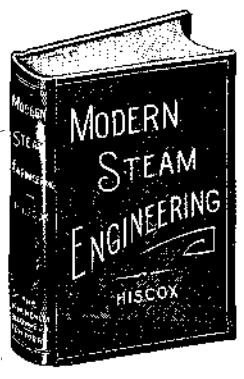

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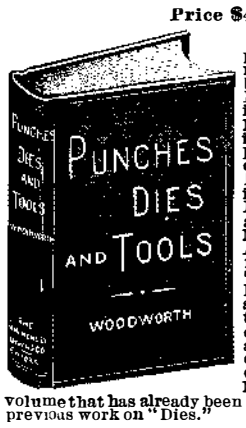

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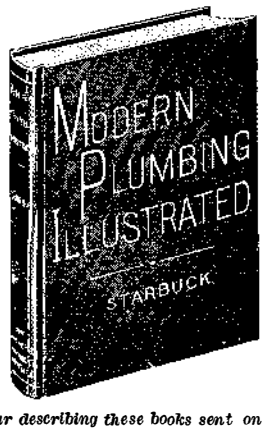

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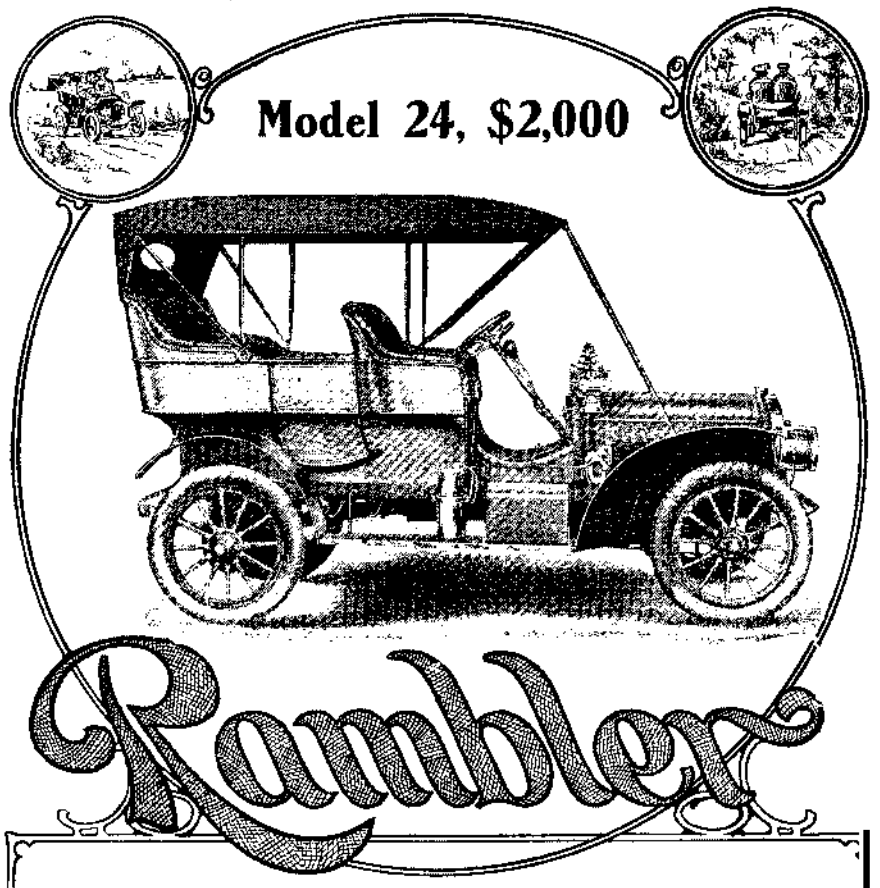

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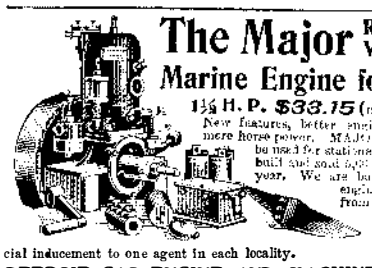

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Medicine, kidney, Van Vleet-Mansfield Drug Co. 61,211
Medicines, certain, Humphreys Homeopathic Medicine Co. 61,160
Metal manufactures, certain, Eberhard Manufacturing Co. 61,151
Metal manufactures, certain, W. Vogel & Bros. 61,154
Metal manufactures, certain, Reading Hardware Co. 61,174, 61,175
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Paper, paper boards, and paper bags, wrapping, Union Bag & Paper Co. 61,120
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Stove polish, W. Wierhake 61,088
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"Chinese," for soap, Michigan Soap Works 13,387
"Gilt Edge," for a metal polish, A. H. Cross 13,390
"S. P. Co.'s," for toilet paper, Scott Paper Co. 13,389
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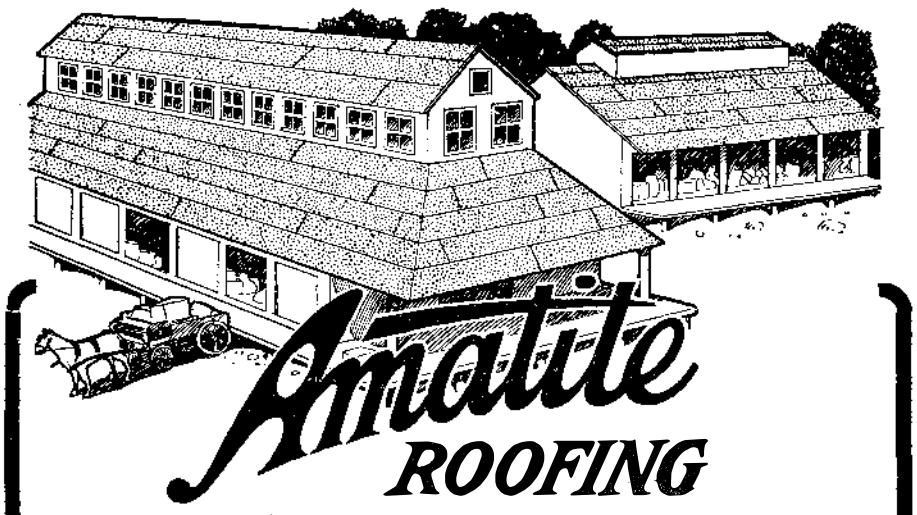

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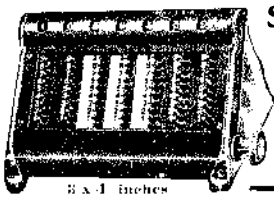

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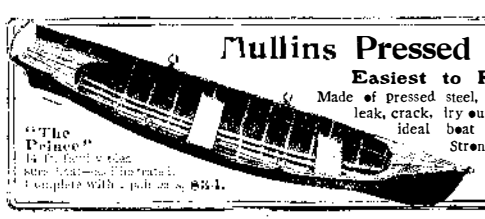

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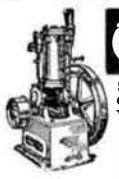

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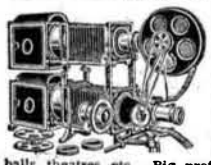

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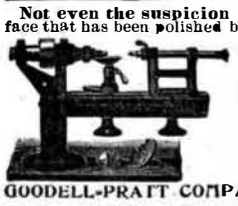

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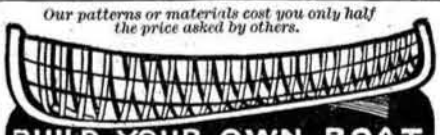

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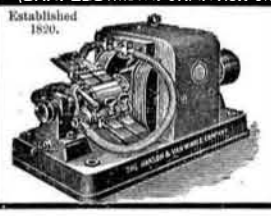

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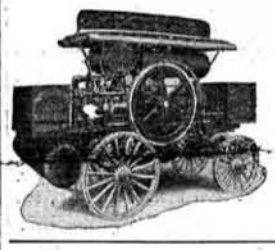

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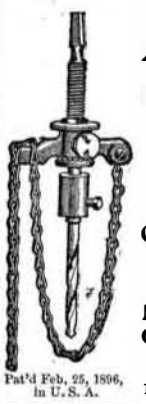

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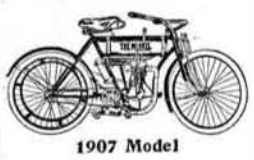

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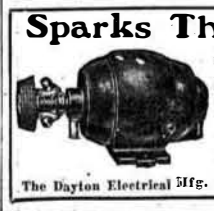

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